



Image Assessment System (IAS)

Critical Design Review

April 8, 1997

IAS Critical Design Review



Agenda

- | | |
|----------------------------------|--------------------------------|
| • Introduction | R. Schweiss |
| • Design Overview | S. Johnston |
| • Hardware Architecture | C. Brambora |
| • Operational Scenarios | S. Johnston |
| • Software Design | |
| – Overview | J. Hosler |
| – Operations Interface | J. Whelan |
| – Management and Control | A. Williard |
| – Database | A. Williard |
| – L1 Processing | T. Ulrich |
| | J. Storey |
| – Evaluation and Analysis | D. Kaufmann/M. Schienle |
| • System Test | E. Crook |
| • Conclusion | R. Schweiss |

IAS Critical Design Review

IAS Technical Review Panel



- **Ludie Kidd/L7 Implementation Manager (Chair)**
- **Jim Irons/Deputy Project Scientist**
- **Darla Werner/EDC L7 Ground System Manager**
- **Jim Ellickson/NOAA**
- **Bill Potter/ MOC Project Manager**
- **Kelly Jeletic/LPGS System Engineer**
- **Dan DeVito/ESDIS- L7 Interface Lead**



- **Introduction**

- **Presentation Purpose**
- **IAS CDR Documentation**
- **On-line Documentation**
- **IAS RIDS**
- **Events to Date / PDR Followup**
- **Purpose of IAS**
- **IAS Requirements Overview**
- **IAS Context Diagram**
- **Issues**

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Presentation Purpose

- **Purpose of review**
 - **Present a synopsis of the IAS Detailed Design Specification and related design material**
 - **Detailed Design encompasses:**
 - **Defining Detailed design for software and hardware CI's**
 - **Refining detailed inter-subsystem interfaces and external interfaces**
 - **Defining a detailed design for the operator-system interface**
 - **Defining a detailed design for the database**
 - **Refining operations scenarios**
 - **Performing further studies and prototypes to guide design**
 - **Defining final test plans**
 - **Documenting the above in specifications, ICDs, plans etc.**
- **CDR covers Design and Implementation/Integration approaches of entire IAS including parts managed and developed at EDC**

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IAS CDR Documentation



- **Accompanying Documentation**
 - IAS Detailed Design Specification
 - IAS Interface Definition Documentation
 - IAS-LPGS ICD
 - IAS System Integration and Test Plan
 - IAS Release Implementation Plan
 - IAS User's Guide (Preliminary)
 - IAS Calibration Parameter File Data Format Control Document
- **Reference Documentation**
 - Landsat 7 Data Format Control Document- Volume 5, Level 0R Output Product
 - Interface Control Document Between EOSDIS Core System (ECS) and the Landsat 7 System, 2/97



- **All IAS documentation and presentations are available for review and printing in PDF format on the IAS web server:**

<http://caster.gsfc.nasa.gov/IAS/>

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IAS RIDS

- **Please submit RIDS to Shaida Johnston no later than April 29, 1997**
 - **Submission can be made by using hard copy RID provided or via email. Please make sure all information necessary on the hard copy is provided on the email version.**
 - **Code 430, Building 16W**
 - **shaida.johnston@gsfc.nasa.gov**
- **Items to RID are:**
 - **Presentation Package**
 - **IAS Accompanying Documentation**

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Events to Dates / PDR Followup

- A formal IAS Preliminary Design Review was conducted in February 1996
 - All Rids from this review have been closed out
- IAS Project Management was restructured in July 1996
- Informal Delta IAS System Design Review/Preliminary Design Review was conducted December 1996
- Two independent software design reviews occurred the week of March 24, 1997 to review the Radiometric Processing System and Geometric Processing System software designs in detail.
 - No major issues were raised at the reviews

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Purpose of IAS

- **Primary IAS Tasks**
 - **Assess quality of LOR Products**
 - **Calibrate instrument and spacecraft**
 - **Support anomaly investigation**

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IAS Requirements Overview

- Retrieve Landsat 7 Level 0R products from the EDC DAAC
- Process the L0R products to produce radiometrically and geometrically corrected level 1R and 1G images
- Remove artifacts while processing L0R data to produce Level 1R images as required
- Assess, on a sample basis, the quality of ETM+ Level 0R products archived by the EDC DAAC
- Perform radiometric and geometric calibrations on selected L7 data
- Monitor and perform long-term trend analyses of system performance and image quality
- Send IAS Calibration Parameter File, problem reports, data quality assessments and processing parameters to the EDC DAAC

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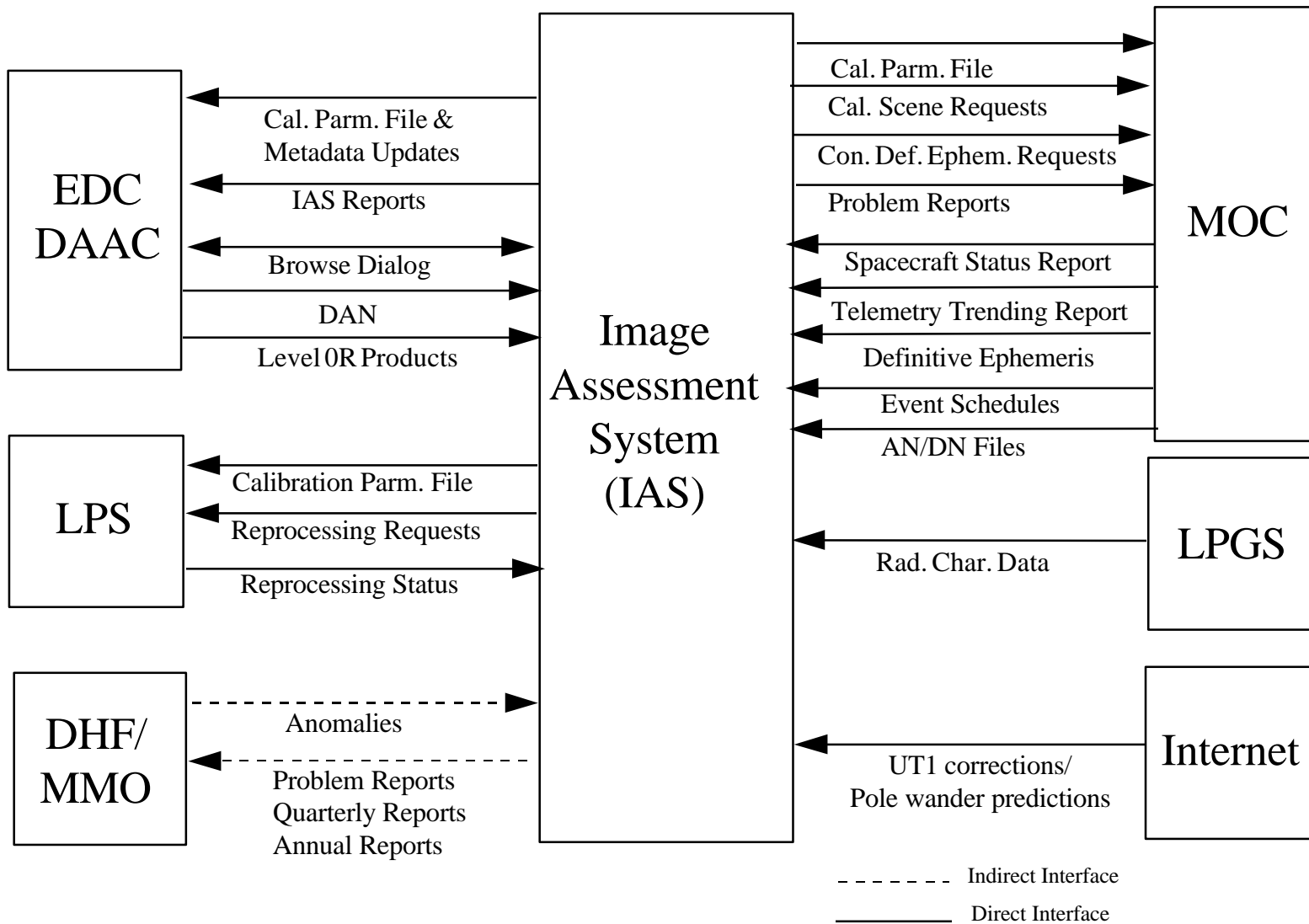
IAS Requirements Overview (cont.)

- **Provide the Calibration Parameter File to the LPS**
- **Receive necessary satellite and instrument performance data from the MOC**
- **Coordinate acquisition of ETM+ image data required for image quality assessment with the MOC**
- **Generate the equivalent of up to ten ETM+ Level 1G systematically correct scenes in a 24 hour day**
- **Produce calibration parameter file updates on an as needed basis (nominally quarterly)**
- **Sustain operations for at least 1 shifts per day, 5 days a week for a minimum mission life of 5 years**

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IAS Context Diagram



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Issues

- **Interface to EDC DAAC for receipt of Level 0R product**
 - Documentation on details for how the IAS receives the Level 0R product has not been available. Design is based on assumption that this is a fairly manual procedure
 - If documentation is located and a more automated approach can be accommodated in the release schedule, the design will be revisited
- **Interface to LPGS for receipt of trending data**
 - Physical connection between LPGS and IAS is not defined thereby leaving a design based on assumptions

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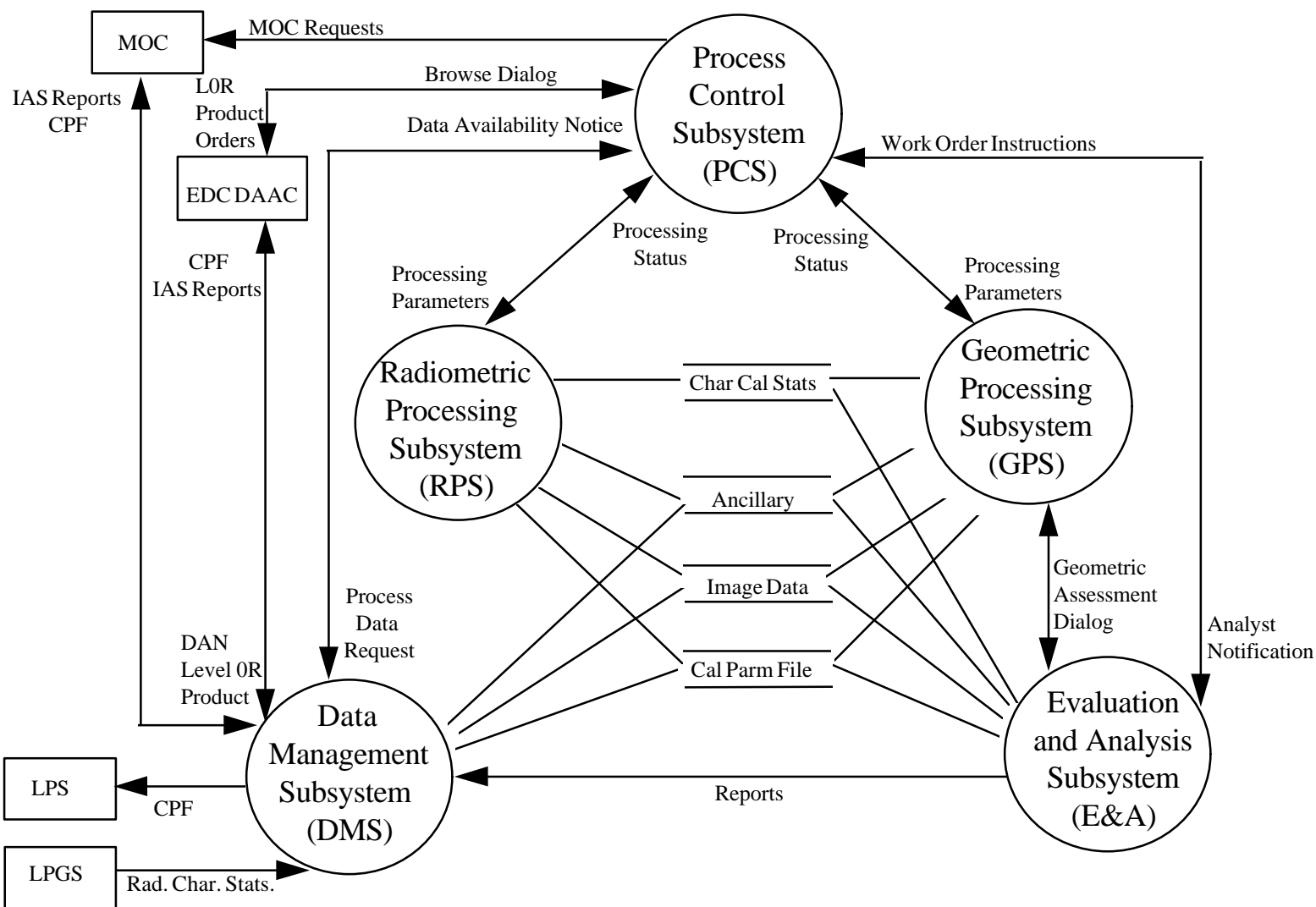
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IAS Subsystems



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IAS Subsystem Definitions (1 of 2)

- **Process Control Subsystem (PCS)**
 - Provides the tools needed by the IAS Operator to plan and manage the processing being performed by the IAS
 - Controls the execution of Radiometric and Geometric Processing Subsystem applications by initiating and managing Work Order processing

- **Data Management Subsystem (DMS)**
 - Manages ingest and storage of data from external systems
 - Performs quality checking and correction of L0R Products
 - Manages IAS on-line data storage and archival
 - Formats IAS outputs for, and manages data transfer to, external systems



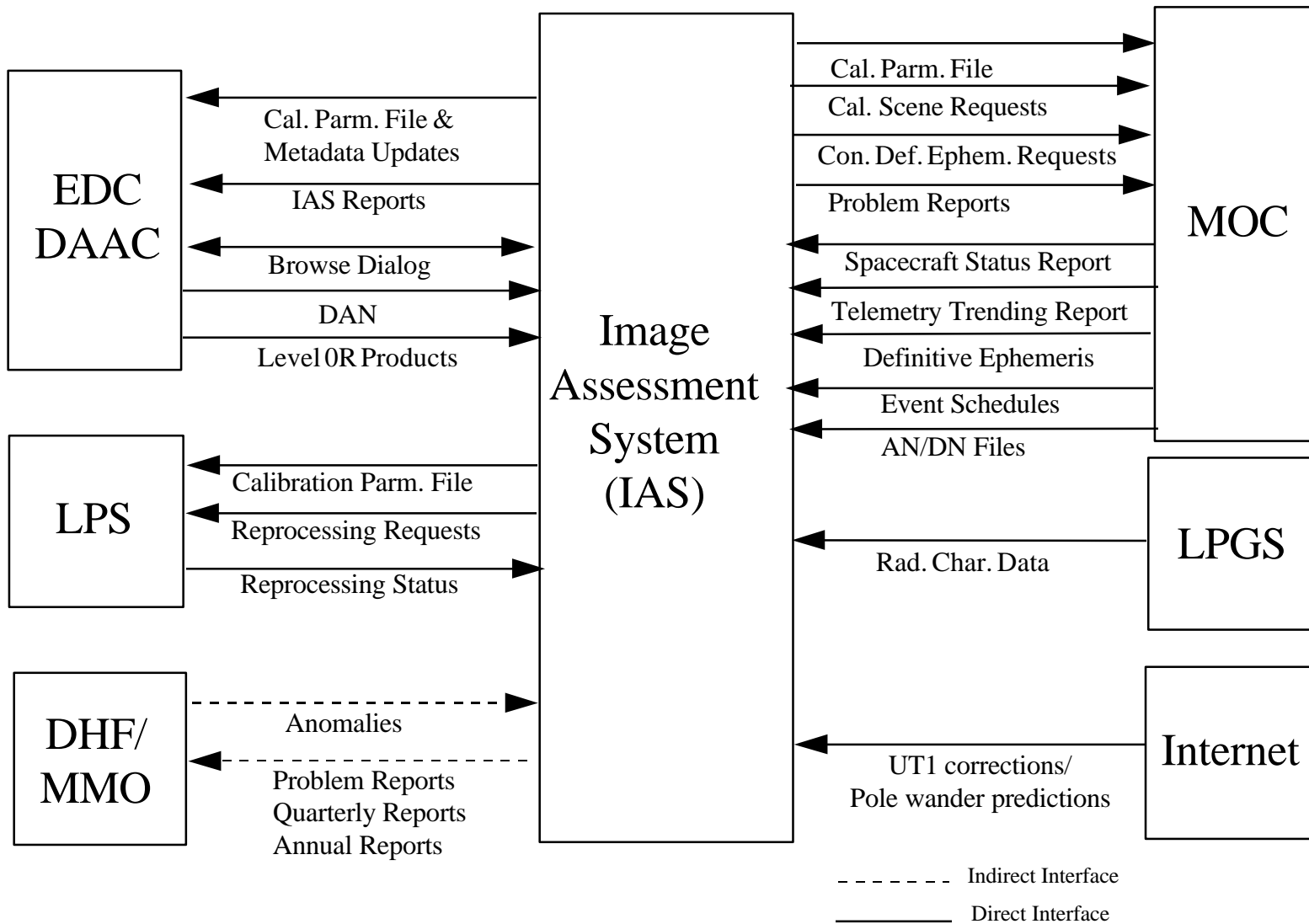
IAS Subsystem Definitions (2 of 2)

- **Evaluation and Analysis Subsystem (E&A)**
 - Provides the Toolkit used by the IAS Analyst in evaluating and analyzing the performance of the ETM+ instrument and in maintaining the Calibration Parameter File
 - Includes tools for viewing IAS inputs and results, image processing, statistical analysis, and report generation
- **Radiometric Processing Subsystem (RPS)**
 - Provides all functionality required for Level 1R product generation, radiometric calibration, and radiometric characterization and evaluation
- **Geometric Processing Subsystem (GPS)**
 - Provides all functionality required for Level 1G product generation, geometric calibration, and geometric characterization and evaluation

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IAS Interfaces





IAS Interfaces

- **IAS to MOC**
 - Landsat 7 MOC to IAS ICD 511-4ICD/0197, Baseline 1/97
 - Update pending lamp cycling issues
 - All transfers using FTP put (MOC and IAS)
 - Two formats for calibration scene requests (PAC/FAC vs. GLC)
- **IAS to LPS**
 - ICD Between IAS and the LPS, 514-1ICD/0195, Rev. 1 7/96
 - CPF sent via FTP (backup via media)
 - Reprocessing Requests via e-mail (backup is paper)
- **IAS to EDC DAAC**
 - ECS to Landsat 7 ICD listed in reference documents
 - Browse dialog and Level 0R Products via user interface
 - IAS gets L0R product when made available
 - CPF to DAAC via IAS notification and DAAC get
 - Reports to EDC DAAC Guide Server

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IAS Interfaces (continued)

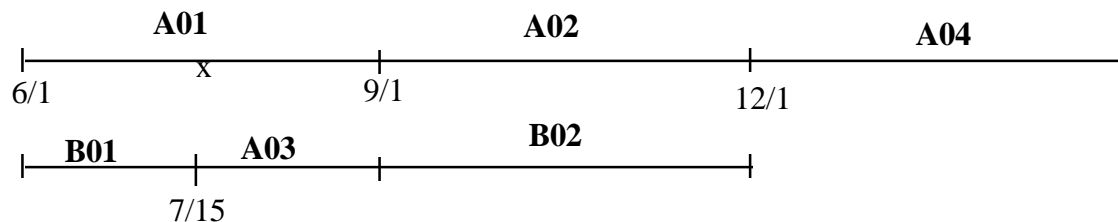
- **LPGS to IAS**
 - **ICD Between IAS and LPGS, Draft 1/97**
 - **Electronic transfer (potential DB link)**
 - **Tape Backup**
- **Other Interfaces**
 - **IAS reports sent to the MMO via e-mail or paper**
 - **Anomalies coordinated with DHF (EDC facility)**
 - **IAS retrieves UT1 corrections from USNO via the internet**

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Calibration Parameter File



- **Format is HDF/ODL**
- **Four components**
 - Radiometric parameters
 - Geometric parameters
 - Time correction coefficients
 - Fixed parameters
- **Distributed to:**
 - LPS for use in Level 0R Processing, ACCA
 - EDC DAAC for distribution with Level 0R products
 - MOC for forwarding to IGSs and use by FDF
- **Updated on regular 90 day cycles at minimum**
 - Effectivity dates (begin/end) first two parameters of file
 - File naming convention (L7yyyydddIASCAL.Vnn)





IAS Reports

- **Calibration Reports**
 - **CRaM Pre-fit**
 - **CRaM (Combined Radiometric Model)**
 - **Ground Look**
 - **Sensor Alignment**
 - **Scan Mirror**
 - **Band Alignment**
- **Assessment (or Characterization) Reports**
 - **Detector Status (Inoperable and degraded)**
 - **Saturated detector**
 - **Impulse noise**
 - **Random noise**
 - **Histogram analysis**

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IAS Reports (continued)

- **Assessment (or Characterization) Reports (cont.)**
 - **Coherent noise**
 - **Scan Correlated Shift**
 - **Memory effect**
 - **Banding**
 - **Striping**
 - **MTF**
 - **TM Initialization (metadata item validation)**
 - **Geodetic Accuracy**
 - **Band to Band Registration**
 - **Image to Image Registration**
 - **Geometric Accuracy**
 - **Level 0R product quality (from ingest and TMINIT checks)**

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IAS Reports (continued)

- **Problem Reports**
 - Identified problem
 - Request for telemetry trending from MOC
- **Anomaly Investigation Reports**
- **Quarterly Summary Reports**
 - Summaries of calibrations and assessments
 - IAS performance summary
 - Any significant problems and trends
 - Changes to CPF and their reasons
- **Annual Reports**

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- **Functional Overview**

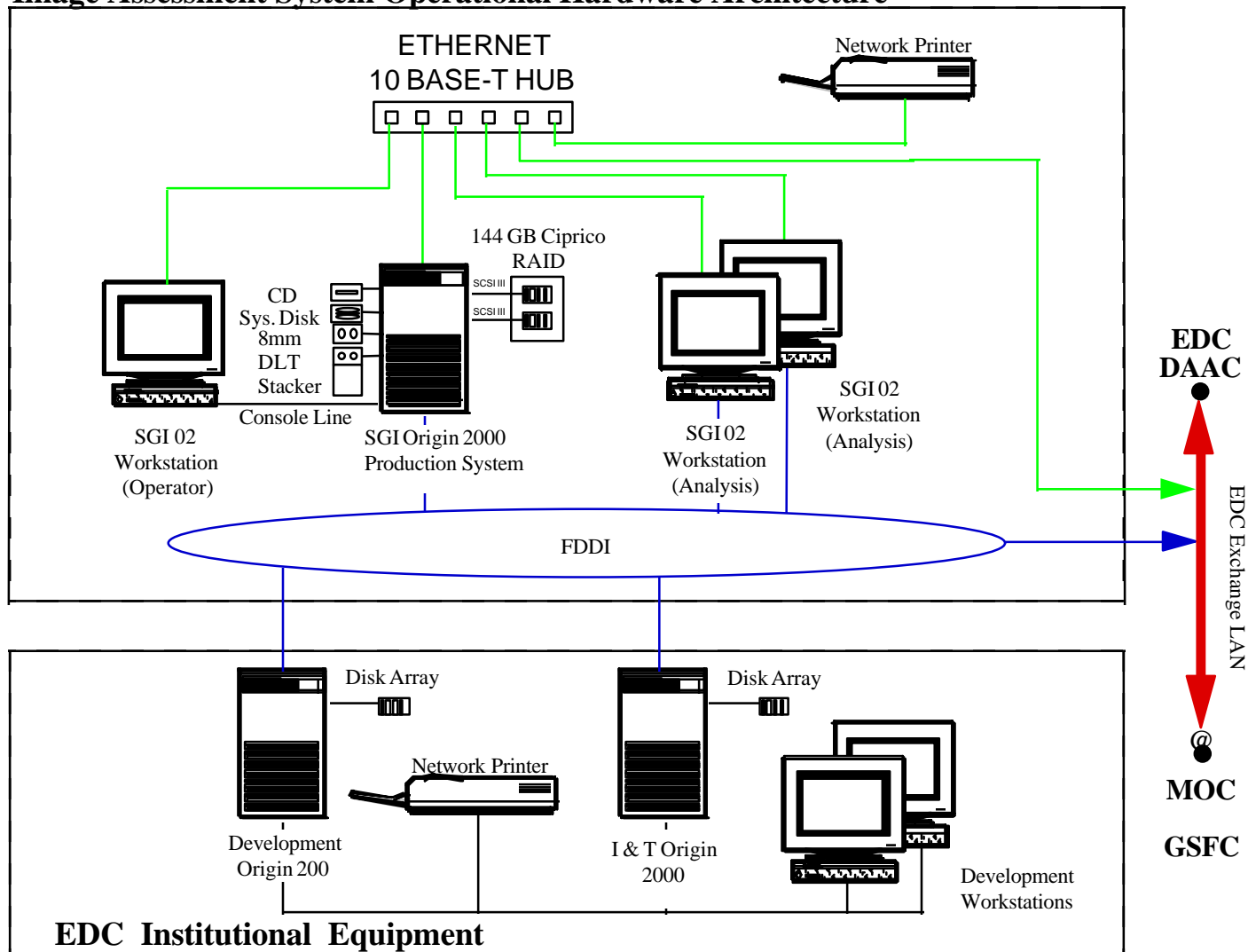
- IAS receives L0R data from EDC-DAAC
- IAS is required to process up to 10 scenes per day (500 MB/scene or 5 GB per day)
- A minimum of 130 GBytes of storage is provided to support processing and temporary L1R and L1G storage for analysis.
- Support Analysts' activities

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IAS Hardware Architecture

Image Assessment System Operational Hardware Architecture





IAS COMPONENTS

- Silicon Graphics Inc. (SGI) Origin 2000 Rack Server**
 - 5.12 GBps Sustained I/O**
 - 4, 195 Mhz. R10000 processors w/ 4MB Cache (expandable to 16 processors within a rack)**
 - 9.1 GB System Disk**
 - 2 GB RAM (expandable to 32 GB within a rack)**
 - Dual Attached FDDI (100 Mbps peak)**
 - SCSI III interfaces (40 MBps peak)**
 - 10/100 BaseT Ethernet (Auto Sensing)**



IAS COMPONENTS

- Silicon Graphics Inc. (SGI) O2 Workstations**
 - Single 150 MHz. R10000 processor**
 - 4.0 GB System Disk**
 - 64 MBytes RAM**
 - Dual Attached FDDI (100 Mbps peak)**
 - SCSI III interfaces (40 MBps peak)**
 - 10/100 BaseT Ethernet**
 - 20'' Color Monitor**



IAS COMPONENTS

- Ciprico Disk Array Subsystem**
 - 72.8 GB total capacity**
 - 8+1 disk configuration (Hot Swap)**
 - Redundant hot swap power supplies**
 - Redundant Array of Independent Disks (RAID) level 3.**
 - SCSI III interface (40 MBps peak)**
 - 2 units concatenated provide over 144 GB of contiguous disk space and 70 MBps sustained read and writes.**



IAS COMPONENTS

- Boxhill Digital Linear Tape Drive (DLT) Mini Library (DLT 4700)**
 - 7 DLT Cartridge Capacity (Robotic loading)**
 - 20 GB capacity/tape (native)
40 GB capacity/tape (compressed)**
 - Total capacity 140 GB native, 280 GB compressed**
 - 1.5 MBps Transfer rate (native)
3.0 MBps (compressed)**
 - SCSI II interface (20 MBps peak)**

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- **Primary IAS Tasks**
 - **Assess quality of L0R Products**
 - **Process images to 1R and 1G levels**
 - **Characterize radiometric artifacts**
 - **Assess geometric accuracies and registrations**
 - **Calibrate instrument and spacecraft**
 - **Radiometry using multiple calibration sources**
 - **Sensor alignment, scan mirror and band placement**
 - **Support anomaly investigation**

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IAS Assessment Table

Scene Type	# to order/ quarter	# to Process /Level	Assessments and Calibrations	Outputs/Reports
Random Day Scene	90	90 /1Gs	Level 0R Product Quality (Table 3.2.2.4-1) Detector Operability Detector Saturation Impulse and Random Noise Banding and Striping	Daily Assessment Report
Geodetic Test Site	6-24	(1) 12-48/1Gs	Geodetic Accuracy Sensor Alignment	Calibration Reports for each Quarterly Report/CPF Update
Geometric Super-Site	2-6	(2) 4-12/1Gt	Scan Mirror Calibration I-I Registration Assessment	Calibration Reports for each Quarterly Report/CPF Update
Focal Plane Cal. Image	4-12	4-12/1Gs	B-B Registration Assessment Band Placement Calibration	Calibration Reports for each Quarterly Report/CPF Update
Night Scenes	(3) 20-44	20-44/1R	Characterize Coherent Noise Char. Scan Correlated Shift Characterize Memory Effect	Assessment Report for each Quarterly Report
PASC Data	(4) 180	180/1Rp	Characterize Memory Effect Rel. Radiometric Accuracy	Calibration Report for each Quarterly Report/CPF update
FASC Data	(5) 8-30	8-30/1Rf	Characterize Coherent Noise Char. Scan Correlated Shift Characterize Memory Effect Rel. Radiometric Accuracy	Calibration Report for each Quarterly Report/CPF update
MTF Image			Characterize MTF	Assessment Report for each Quarterly Report/ CPF update
Ground Look Calibration	1	1/1Gt	Absolute Rad. Accuracy	Calibration Report

(1) For each of the 6-24 scenes, process PAN band once to 1G systematic using PCD ephemeris and once again using FDF definitive ephemeris for a range of 12-48.

(2) For each of the 2-6 scenes, process PAN band to 1G systematic and then to 1G terrain corrected.

(3) Optimally, a 20 scene interval is desired once per quarter. Additionally, the non-bright scenes acquired with the PASC images will be ordered 2 per week.

(4) PASC imaging is scheduled once per day, each PASC acquisition is approximately 6 scenes in length with the bright area of interest covering 2 scenes that will be ordered (90x2). Each scene will be processed to 1R level using a unique PASC processing algorithm.

(5) FASC imaging is scheduled once every six weeks, therefore could be acquired once or twice in a quarter. There are two types of FASC imaging; one collecting 8 scenes when done in conjunction with PASC imaging and one collecting 15 images when done on a stand alone basis.



IAS User Types

- **Operators**
 - Process image data and monitors the system
 - Order data from DAAC
 - Generate MOC requests, DAAC transfer requests & CPF
 - Transfer files
 - Setup, modify and monitor Work Orders (WOs)
 - Monitor system status, messages and alerts
 - Query Database
 - Startup/Shutdown of IAS software
- **Analysts (Radiometry and Geometry)**
 - Display and edit IAS data
 - Analyze IAS data
 - Generate Reports
 - Submit Jobs



Scenarios

- **Ordering Data**
 - MOC Acquisition Requests
 - Level 0R data from DAAC
- **Defining a Work Order**
 - Standard Processing Procedures
 - Work Order Setup
- **Analyze Results**
- **Generation of Primary Output Products**
 - Calibration Parameter File
 - Reports
- **Anomaly Investigation**

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Generate MOC Request

- **Calibration Scene Request**
 - User specifies if this is a PAC/FAC (orbit number based) or Ground Look Calibration (WRS path/row based) request
 - Tools available for orbit number and path/row determination
 - COTS tool to display ground track
 - Weekly MOC AN/DN file (includes times, longitudes, and orbit numbers)
 - User fills in a form specifying the appropriate information
 - Multiple requests may be put into a single request file
 - Requests are tracked in the database



Generate MOC Requests (continued)

- **Concentrated Ephemeris Request**
 - User fills in a form specifying the start and end times for the requested data or selects a LOR product and the times are automatically extracted
 - Multiple requests may be put into a single request file
 - Request file is created and staged for transfer to the MOC
 - Requests are tracked in the database

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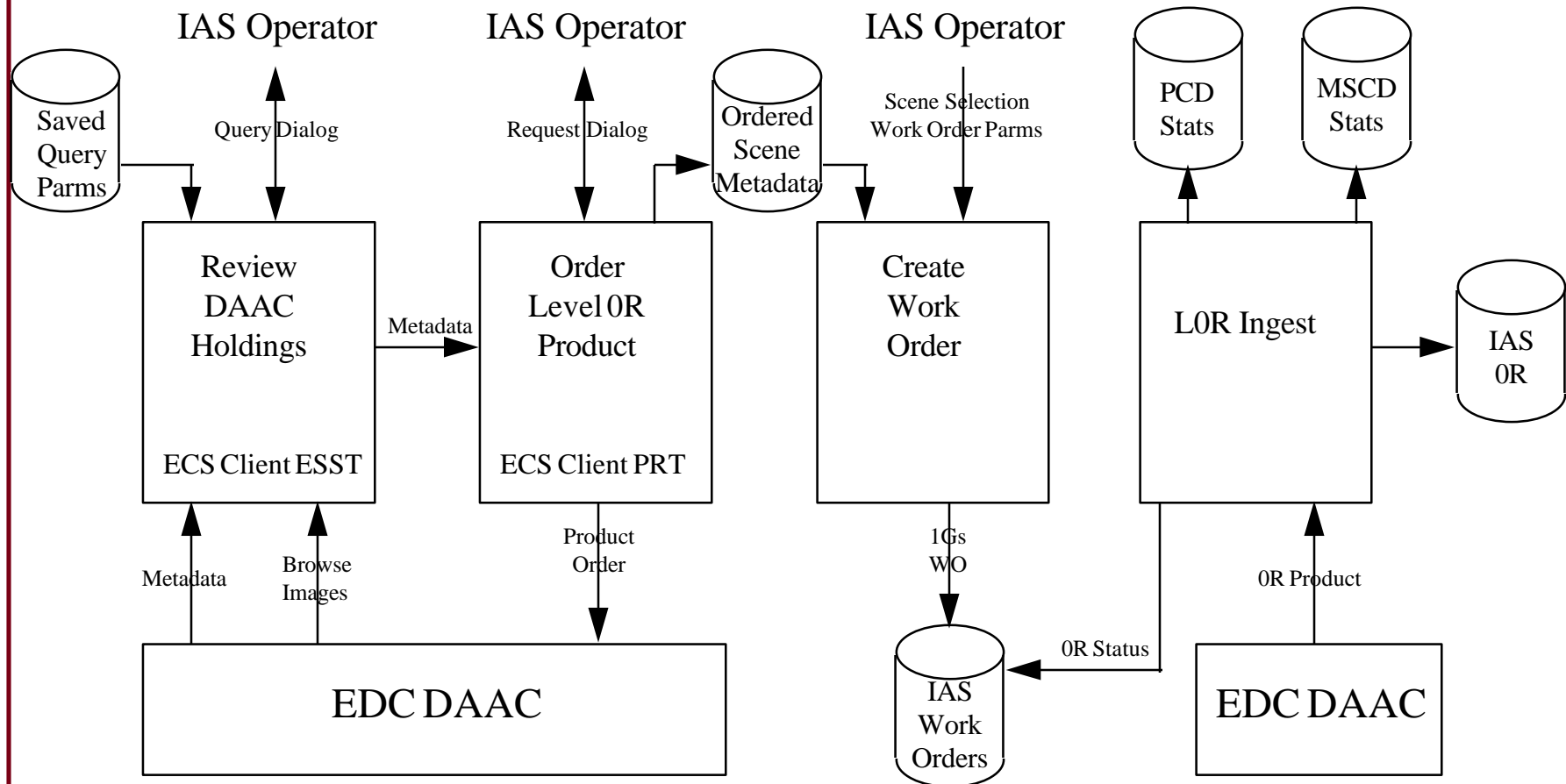
Order Data From DAAC

- **Connect to DAAC via Web Browser**
- **Query/browse for desired scenes**
- **Select and order scenes**
- **Create IAS Work Order with corresponding scene ids**
- **DAAC notifies IAS when data is available and IAS ftps data**
- **Data products are checked for completeness**
- **IAS catalog updated with data product information**
- **Received data products checked against outstanding Work Orders and operator notified if no matches found**

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Order and Receive Data



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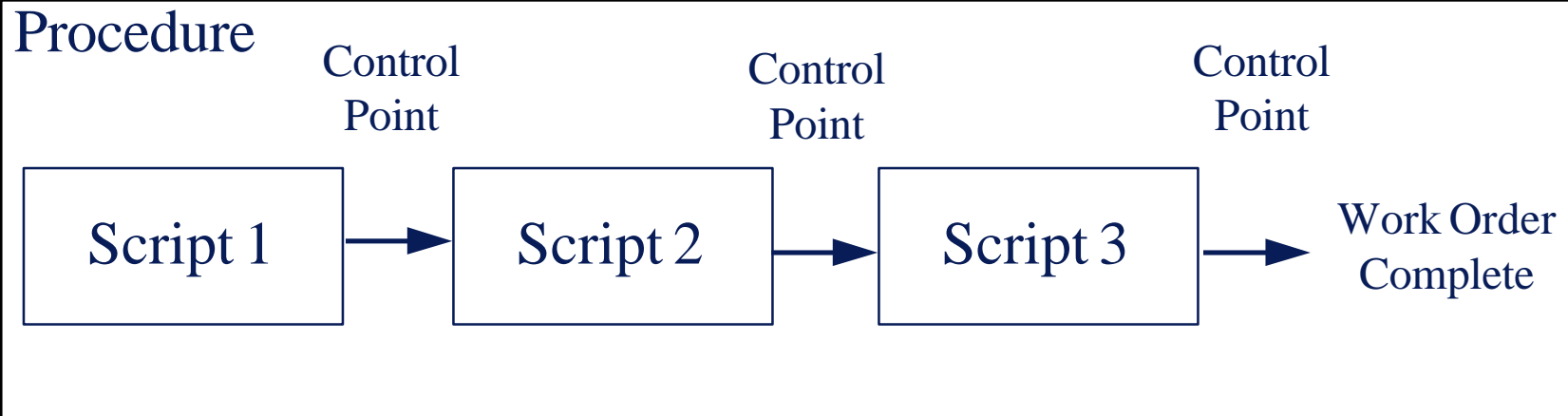
Scenarios

- **Ordering Data**
 - MOC Acquisition Requests
 - Level 0R data from DAAC
- **Defining a Work Order**
 - Standard Processing Procedures
 - Work Order Setup
- **Analyze Results**
- **Generation of Primary Output Products**
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What is a Work Order?

- **A Work Order is the set of input data, control parameters, and the procedure for processing a LOR input product.**
- **Named procedures consist of a set of processing scripts**
- **Scripts execute application programs to process data**
- **Application programs obtain input parameters as needed**
- **Process Control System controls the execution of the scripts**
- **Scripts can be set to pause when complete for analysis of results**





Standard Processing Procedures

- **PASC Scenes**
- **FASC Scenes**
- **Night Scenes**
- **Day Scenes**
 - **Level 1Gs**
 - **Level 1Gp (interactive and automated)**
 - **Level 1Gt (interactive and automated)**
 - **Geodetic accuracy**
 - **Sensor alignment calibration**
 - **Geometric supersite**
 - **Image registration**
 - **Band to band registration**



Work Order Setup

- **New Work Order**
 - User specifies a new Work Order and a form is displayed for the user to enter information
 - List of values and default values are supplied where appropriate
 - Input data is specified, if known
 - User selects processing procedure to apply to the input data
 - Processing parameters associated with the processing procedure are selected
 - Work Order is committed to the system
 - Process Control Subsystem will schedule the Work Order for processing once all required input data are available

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Work Order Setup (Cont'd)

- **Modify Existing Work Order**
 - User queries system for existing Work Order
 - Work Order attributes are displayed and the user may make and commit changes
- **Fields associated with Work Order setup**
 - work order number (generated by system)
 - date entered (generated by system)
 - requester (generated by system)
 - priority
 - request type
 - requested completion date
 - processing procedure (submenu for input parameter selection)
 - input data specification
 - comments

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Scenarios

- **Ordering Data**
 - MOC Acquisition Requests
 - Level 0R data from DAAC
- **Defining a Work Order**
 - Standard Processing Procedures
 - Work Order Setup
- **Analyze Results**
- **Generation of Primary Output Products**
 - Calibration Parameter File
 - Reports
- **Anomaly Investigation**

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Analysis of Results

- **Execution of a processing procedure results in trending and calibration information**
- **Results may be reviewed at the end of each script or at the completion of the Work Order**
 - **Dummy scripts may be created to inform analyst of specific analysis steps needed**
- **Processing history logs and intermediate products are generated in a Work Order specific directory**
- **E&A functions are used to view and analyze intermediate products and end results**
- **Cleanup of temporary files and archive of status files will begin once analyst has indicated that their review of the results is complete**



Scenarios

- **Ordering Data**
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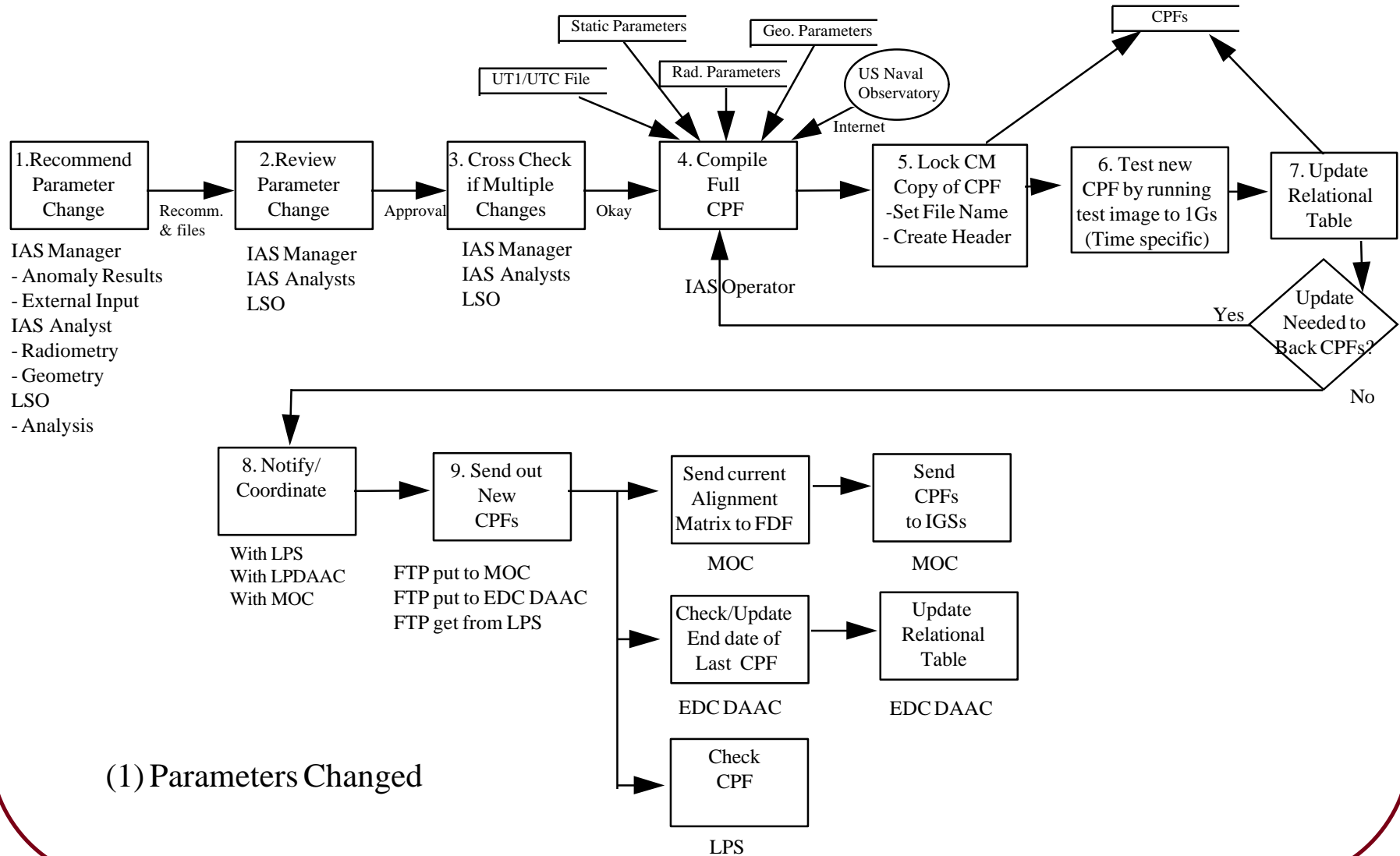
Generate Calibration Parameter File

- **Calibration parameter files are generated and maintained in ODL files**
- **To generate a new CPF the user runs a tool to process and write the calibration information to a named ODL file**
- **The database is updated to indicate that a new CPF has been generated**
- **The new CPF is reviewed/verified before being released for distribution**

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Update Calibration Parameter File (1)



(1) Parameters Changed

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Backup Notes for CPF Scenario (1)

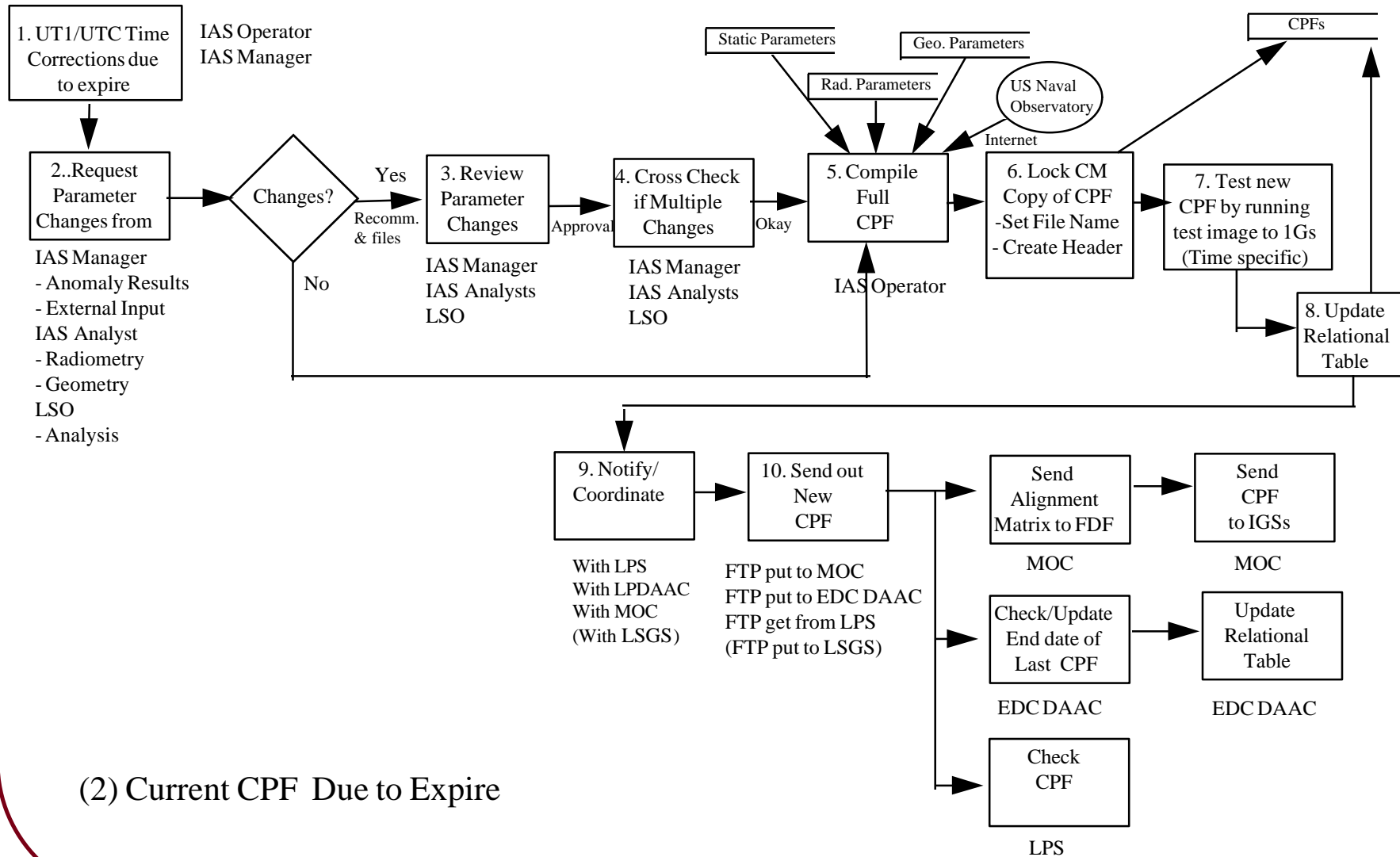
1. Each of the entities that can make recommendations (IAS Manager, IAS analysts, and LSO) may be working with different subsets of the information which comprise the CPF such that a recommendation for use of new parameters would have to come with the appropriate file name and location. An analyst or operator would use these subset files to update the database (before or after review?) and then generate the CPF. There are four components of the CPF (see box 4) and analysts/scientist can be working with either the radiometry file and/or the geometry file.
- 2 & 3. The full team (IAS Manager, analysts and LSO staff) will review proposed parameters changes and cross check their effects on each other if there are multiple changes.
4. The full calibration parameter file (CPF) will be compiled from the four components (static values, approved radiometry file, approved geometry file, and appropriate time correction file that will be retrieved from the US Naval Observatory site via the internet).
For previously transmitted file updates, the appropriate time correction file will be obtained from the IAS database for inclusion.
5. The configuration managed (CM) version of the file is saved and the file name (format in the CPF document) and the header (containing effective start date and end date) are created.
6. As a quality check, the newly generated CPF will be used to create a 1Gs image and checked. The image selected must match the time frame in which the CPF is effective.
7. The relational table is envisioned to contain effective dates (with no overlapping times) and the corresponding CPF file names to be used for that time span.
- 7a. If it is necessary to update previously transmitted CPFs, then new CPFs for past time frames must be compiled, checked, given new file names and headers, the relational table updated and transmitted to the appropriate Landsat 7 elements also. The loop will continue until no more back (or previously transmitted) files need to be updated.

Steps after step 9 are not within the IAS.

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Update Calibration Parameter File (2)



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Generate Reports

- The following products are generated as a result of the analysis of the Work Order processing:
 - Relevant assessment (or characterization) reports
 - Radiometric artifacts
 - Applicable geometric characterizations
 - Level 0R product quality assessment
 - Calibration report if required number of scenes are present
- As required, the IAS will generate:
 - Problem reports
 - Anomaly investigation reports
- IAS produces quarterly and annual summary reports regularly

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Scenarios

- **Ordering Data**
 - MOC Acquisition Requests
 - Level 0R data from DAAC
- **Defining a Work Order**
 - Standard Processing Procedures
 - Work Order Setup
- **Analyze Results**
- **Generation of Primary Output Products**
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 - Reports
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Anomaly Resolution

- The same tools used in normal processing are available for anomaly resolution and “what if” processing.
- Analyst sets up Work Order using standard or custom scripts
- Analyst can control execution of scripts (e.g. go backwards in procedure to rerun scripts)
- Results are “tagged” to differentiate them from normal processing runs
- The analyst may require trending data from the MOC to aid in the analysis of an anomaly. Request to the MOC for trending reports are made via an IAS Problem Report.

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J. Storey |
| – Evaluation and Analysis | D. Kaufmann/M. Schienle |
| • System Test | E. Crook |
| • Conclusion | R. Schweiss |



- **Overview**
- **Operations Interface**
- **IAS Management and Control**
- **IAS Database**
- **L1R Processing**
- **Evaluation and Analysis**



- **Design Process**
 - **SSDM Structured Design Methodology**
 - **Bottom-Up Design for Radiometric and Geometric Processing Subsystems**
 - **Top-down Design for Remaining IAS Subsystems**
- **Design Products**
 - **Preliminary: Completed Top Two Levels of Structure Charts and Unit Statements**
 - **Detailed: Completed Structure Charts, Module Specifications and Data Dictionary**



- **Design Products (Cont.)**
 - Detailed Design Specification
 - Interface Definitions Document
 - Entity-Relationship Diagram
 - Physical Schema Diagram
- **IAS Project Standards**
 - On-line Documentation
 - Procedures and Conventions
 - IAS Standards and Procedures Notebook
 - CADRE/Teamwork
 - Structured Design



- **IAS Project Standards (Cont.)**
 - **RTM**
 - **Requirements Traceability**
 - **Oracle Designer 2000**
 - **Database Development**
 - **Oracle Forms**
 - **Operations Interface**



Issues

- **Mechanism for EDC DAAC to notify IAS on availability of LOR product is TBD**
- **Mechanism for LPGS to transfer trending data to IAS is TBD**
- **Detailed layout of reports provided to MMO is TBD**
- **Transfer of products to EDC DAAC is a manual process (DAAC GUI used to specify file and location)**



Assumptions

- **EDC DAAC Interface**
 - **DAAC connects to socket on IAS**
 - **DAAC sends data availability notification (DAN)**
 - **IAS closes socket connection**
 - **IAS expect unique product id in DAN as provided to IAS when product was ordered**



Design Drivers / Constraints

- **Multiple Image Assessment Processing**
 - **Work Order Processing**
- **System Users**
 - **User Interface to Support Multiple User Types**
 - **Operators**
 - **Analysts**
 - **Work Order Tuning**
 - **“What if” Analysis**
- **Schedule**



- **Global Routines**
 - **Common API for Radiometric and Geometric Processing**
- **Database Interface**
 - **Database Access Routines to Isolate SQL Statements and Stored Procedures**



Principal Functions

- **Request and Receive Data**
 - **EDC DAAC**
 - **L0R Product**
 - **MOC**
 - **Partial Aperture Solar Calibrator (PASC)**
 - **Full Aperture Solar Calibrator (FASC)**
 - **Ground Look Calibration (GLC)**
 - **Concentrated Ephemeris**
 - **LPGS**
 - **Radiometric Characterization Data**
- **Data preparation for processing**



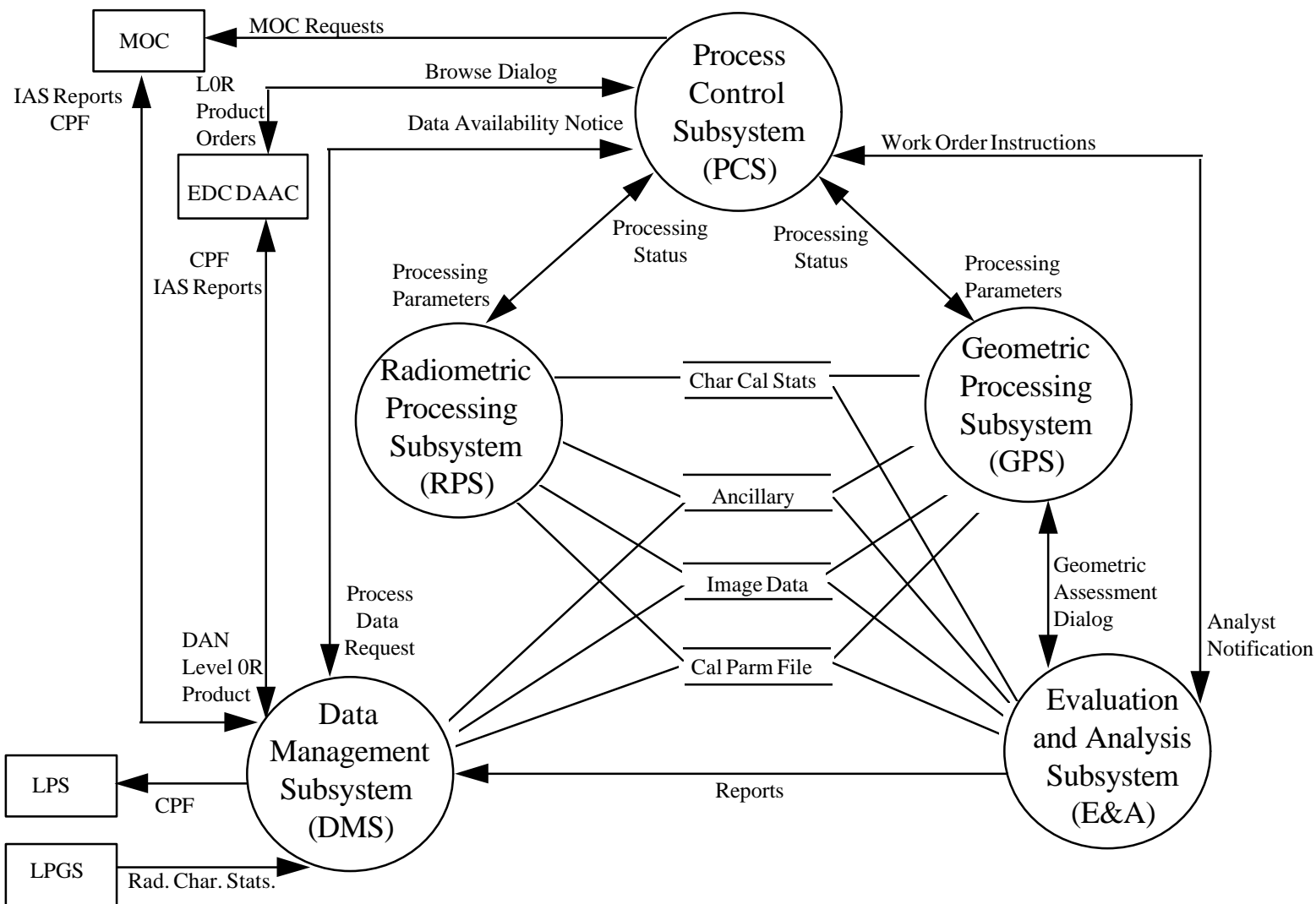
Principal Functions (Cont.)

- **L1R Processing**
 - Radiometric Calibration
 - Radiometric Characterization
 - Level 1R Processing
 - Geometric Calibration
 - Geometric Characterization
 - Level 1G Processing
- **Verification of Data Quality**
- **Evaluation and Analysis**
- **Distribution of Products**
 - Calibration Parameter File to the DAAC, MOC, LPS
 - Produce Image Quality and Trending Reports

IAS Critical Design Review



Top Level Architecture





Top Level Architecture (Cont.)

- **Data Management Subsystem (DMS)**
 - **Ingest L0R Product from EDC DAAC**
 - **Validate and Correct L0R Product**
 - **Ingest Ephemeris and Reports from the MOC**
 - **Generate Calibration Parameter File (CPF)**
 - **Distribute Products to External Facilities**
 - **Monitor Disk Usage**



Top Level Architecture (Cont.)

- **Process Control Subsystem (PCS)**
 - **Schedule Work Order for Processing**
 - **Monitor Progress of Work Order**
 - **Notify Analyst for Intermediate Action on Halted Work Order**
 - **Notify Analyst for Assessment of Completed Work Order**



Top Level Architecture (Cont.)

- **Radiometry Processing Subsystem (RPS)**
 - **Perform Radiometric Calibration**
 - **Uses a number of calibration sources:**
 - **Internal Calibrator**
 - **PASC**
 - **FASC**
 - **GLC**
 - **Optimally combined the results from each calibration source (Combined Radiometric Model)**
 - **Result are gains and biases**



Top Level Architecture (Cont.)

- **Radiometry Processing Subsystem (RPS) (cont.)**
 - **Perform Level 1R Processing**
 - **Characterize data quality and artifacts in the images**
 - **Convert each pixel in a scene to absolute radiance prior to L1G processing**
 - **Apply calibration (gains and biases)**
 - **Correct artifacts (striping, banding, impulse noise, dropped lines, etc.)**
 - **Populate trending databases**
 - **Short term (per orbit)**
 - **Long term (life of mission)**



- **Geometric Processing Subsystem (GPS)**
 - **Perform Level 1G Processing**
 - **Create a systematic sensor/spacecraft model based on the L0R PCD and MSCD**
 - **Relate input image space detectors to output ground space locations using the model**
 - **Resample calibrated (L1R) input pixels to create systematic (1Gs) images**
 - **Update the model using ground control point measurements**
 - **Resample the input L1R data using the updated model and optionally remove terrain effects to create precision (1Gp) or terrain corrected (1Gt) images**
 - **L1G images used to perform geometric characterization and calibration**



Top Level Architecture (Cont.)

- **Geometric Processing Subsystem (GPS) (cont.)**
 - **Characterize L7/ETM+ Geometric Performance**
 - **Compare L1G products to ground control points and reference images for geometric test sites**
 - **Measure band-to-band registration**
 - **Populate trending database**
 - **Perform Geometric Calibration**
 - **Estimate updates to sensor/spacecraft geometric parameters**
 - **Retain best fit parameters in trending database**
 - **Provide geometric input to CPF generation**



Top Level Architecture (Cont.)

- **Evaluation & Analysis Subsystem (E&A)**
 - **ASCII and Image File Display**
 - **Formatted Dumps and Hardcopy Outputs of Images**
 - **Editing of System Input and Output Files, including Image and Calibration Parameter Files**
 - **Image Analysis**
 - **Statistical and Trending Analysis**
 - **Report Generation**
 - **Screen Display of All Plots/Reports**
 - **Access to WO Submission Mechanism**
 - **Access to Custom IAS Applications for Radiometric and Geometric Assessment and Evaluation**
 - **Post WO Assessment**
 - **Series of WO (trending)**



Interactive Interface

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

Database

IAS Critical Design Review



Agenda

- **Introduction** R. Schweiss
- **Design Overview** S. Johnston
- **Hardware Architecture** C. Brambora
- **Operational Scenarios** S. Johnston
- **Software Design**
 - **Overview** J. Hosler
 - **Operations Interface** J. Whelan
 - **Management and Control** A. Williard
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J. Whelan

Interactive Interface

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

Database

IAS Critical Design Review



Operator and Analyst User Interfaces

Operator Functions

- start system
- shutdown system
- set up system parameters
- archive to tape
- create new procedure

Analyst Functions

- set up, control, and monitor work orders
- generate Calibration Parameter File
- request data
- view catalogs
- view system activity
- perform image analysis
- execute custom IAS applications
- analyze trending data
- generate reports



Image Assessment System (IAS)

System Work Order Request Files Cal Parm File Monitor

Welcome to the Image Assessment System (IAS)

for Landsat 7

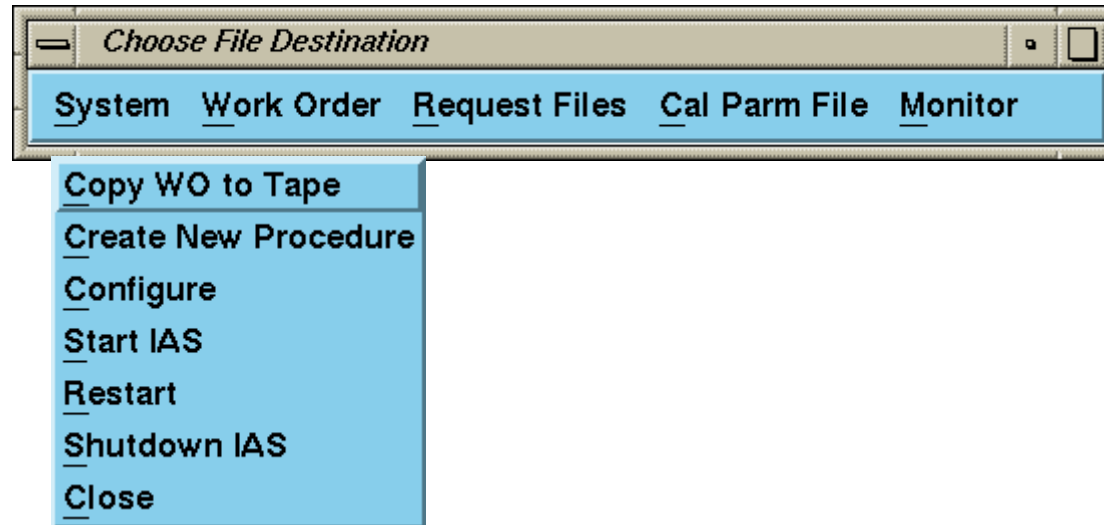
Not currently implemented
Count: *0

<Insert>

IAS Critical Design Review



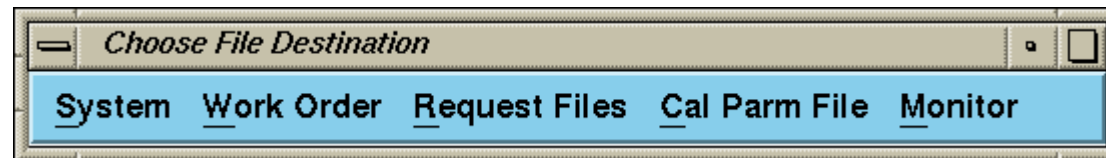
Main Menu - System



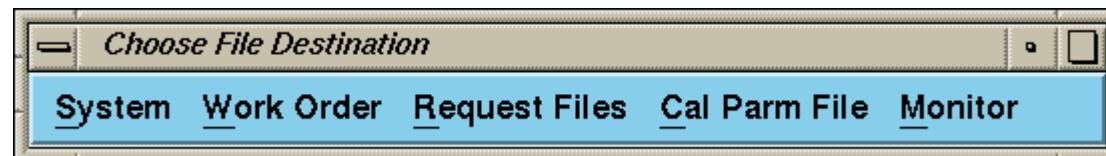
IAS Critical Design Review



Main Menu - Work Order



- * Create ▶ New
- * Update Product Id From Template Series
- * Processing ▶ Series
- * Delete
- * Browse Parameters
- * Status



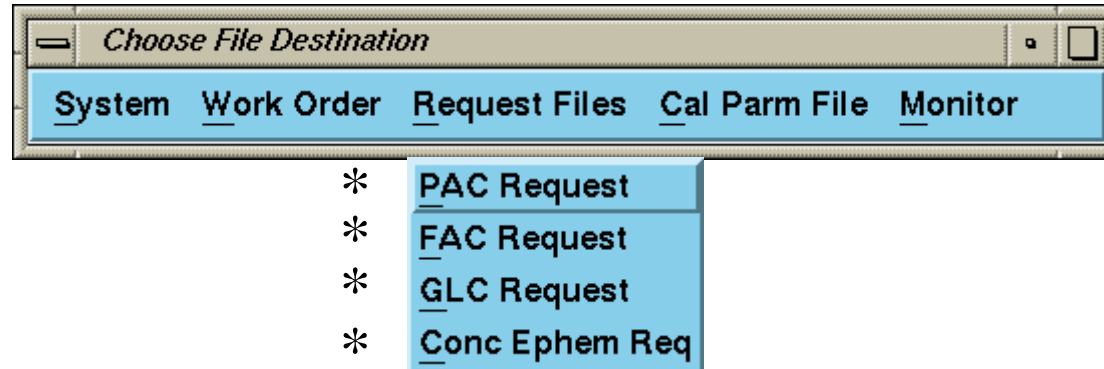
- Create ▶
- Update Product Id
- * Processing ▶ Continue
- Delete Abort
- Browse Parameters Completed
- Status

* Accessible from analyst user interface

IAS Critical Design Review



Main Menu - Request Files

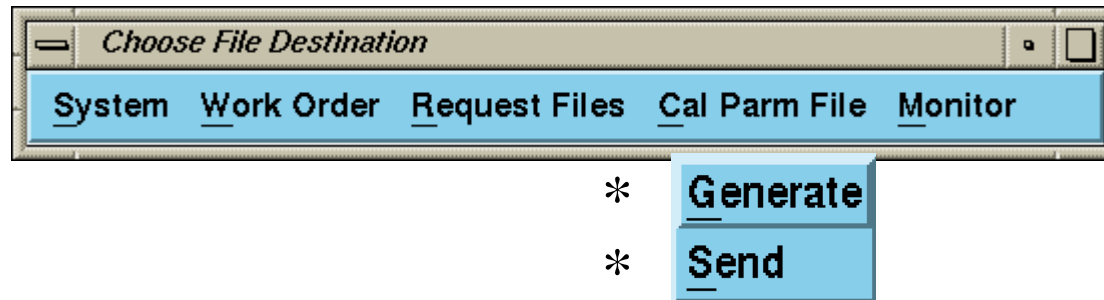


* Accessible from analyst user interface

IAS Critical Design Review



Main Menu - Cal Parm File

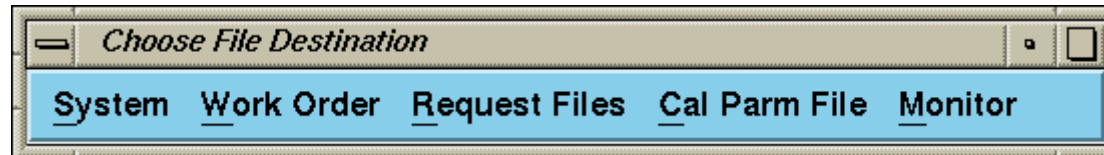


* Accessible from analyst user interface

IAS Critical Design Review



Main Menu - Monitor



- * Events
- * LOR Products
- * Transfers
- * Query Database

* Accessible from analyst user interface

IAS Critical Design Review



Ordering Data (from MOC) -- Cal Scene Req

Cal Scene Request for FAC (by Orbit Number)

System Work Order Request Files Cal Parm File Monitor

REQUEST FOR A FAC/PAC CALIBRATION SCENE

File Prefix Version

Request Type

Calibration Lamp ☒ On ☐ Off

Lamp Sequence Mode ☒ None ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Orbit Number

Start Angle

End Angle

Gain

Destination

Count: *0 <Insert>

IAS Critical Design Review



Ordering Data (from MOC) -- Cal Scene Req (cont'd)

Gains for Each Band

System Work Order Request Files Cal Parm File Monitor

Choose the Gain for Each Band

Band Id 1	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 2	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 3	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 4	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 5	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 6 Format 1	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 6 Format 2	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 7	<input type="radio"/> Low	<input type="radio"/> High	<input type="radio"/> Default
Band Id 8	<input type="radio"/> Low	<input type="radio"/> High	<input checked="" type="radio"/> Default

OK RESET



Ordering Data (from MOC) -- Cal Scene Req (cont'd)

Choose File Destination

System Work Order Request Files Cal Parm File Monitor

SELECT A DESTINATION

TARGET HOST:

Host Name

Address

Def Target Path

IAS HOST:

Def IAS Directory

OK RESET

IAS Critical Design Review



Define a Work Order

System Work Order Rquest Files Cal Parm File Monitor

CREATE WORK ORDER

Requester: Current Time:

Start Date: Req Compl Date:

Request Type: ☒ Std ☐ Test ☐ Custom

Priority: ☒ High ☐ Medium ☐ Low

Ephem Type: ☒ PCD ☐ Def ☐ Concen

Work Order Directory:

Calibration Parameter File:

Procedure Id:

LOR Product Id:

Work Order Comment:

Modify Parameters:

Count: *0 <Insert>

IAS Critical Design Review



Define a Work Order (cont'd)

Modify Parameters at Script Level

System Work Order Request Files Cal Parm File Monitor

MODIFY PARAMETERS AT SCRIPT LEVEL

Procedure Id:

Script Id

<input type="text"/>	<input type="checkbox"/> Pause
<input type="text"/>	<input type="checkbox"/> Pause
<input type="text"/>	<input type="checkbox"/> Pause
<input type="text"/>	<input type="checkbox"/> Pause

Parm Name	Array Element	Parm Value
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

OK CANCEL

Count: *0 <Insert>

IAS Critical Design Review

Define a Work Order (cont'd)



System Work Order Rquest Files Cal Parm File Monitor

CREATE PROCEDURE

Procedure Name:

Select script Id from the following list and click "ADD"

Script Id:
<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

Procedure Script List: click "DELETE" to delete from the list

Script Id:	Seq. No.
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>

OK

CANCEL

Count: *0

<Insert>

IAS Critical Design Review



Monitor a Work Order

Work Order Status

System Work Order Rquest Files Cal Parm File Monitor

WORK ORDERS STATUS

Refresh Rate: Seconds

Work Order Id	LOR Product Id	Procedure Id	Script Id	State

Work Order Path:

LOR Path:

Count: *0 <Insert>

IAS Critical Design Review



Monitor a Work Order (cont'd)

Work Order Status

System Work Order Request Files Cal Parm File Monitor

WORK ORDER SCRIPT STATUS

Work Order Id:

Type:

Work Order State:

Procedure Id:

Script Id	State	Exit Code
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

Parm Name	Array Element	Parm Value
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

OK CANCEL

Count: *0 <Insert>

IAS Critical Design Review

Monitor a Work Order (cont'd)



EVENTS_WINDOW

System Work Order Request Files Cal Parm File Monitor

TIME/WORK ORDER EVENTS

Filter by: ☒ Time ☐ Work Order ☐ Program Id

Date/Time	Work Order Id	Script Id	Program Id	Brief Message	Detailed Message

Count: *0 <Insert>

IAS Critical Design Review



Generate Primary Output Products -- Cal Parm File

Generate Calibration Parameter File

System Work Order Request Files Cal Parm File Monitor

GENERATE CALIBRATION PARAMETER FILE

Current Path of Baseline Configuration File

Path of Radiometry File

Path of Geometry File

Path/Name of UTC File

Path of New Calibration Parameter File

Count: *0 <Insert>



Generate Primary Output Products -- Cal Parm File

SEND_CAL_PARM_FILE_WINDOW

System Work Order Request Files Cal Parm File Monitor

SEND CALIBRATION PARAMETER FILE

SELECT FILE: **Filename**

☐

☐

☐

Directory

NOTE PATH:

NOTIFY DAAC: ☐ Yes ☐ No

FTP FILE:

Host Name

Address

Def Target Path

SEND **CANCEL**

Count: *0 <Insert>

IAS Critical Design Review



Agenda

- | | |
|----------------------------------|--------------------------------|
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Interactive Interface

A. Williard

**Management &
Control**

L1 Processing

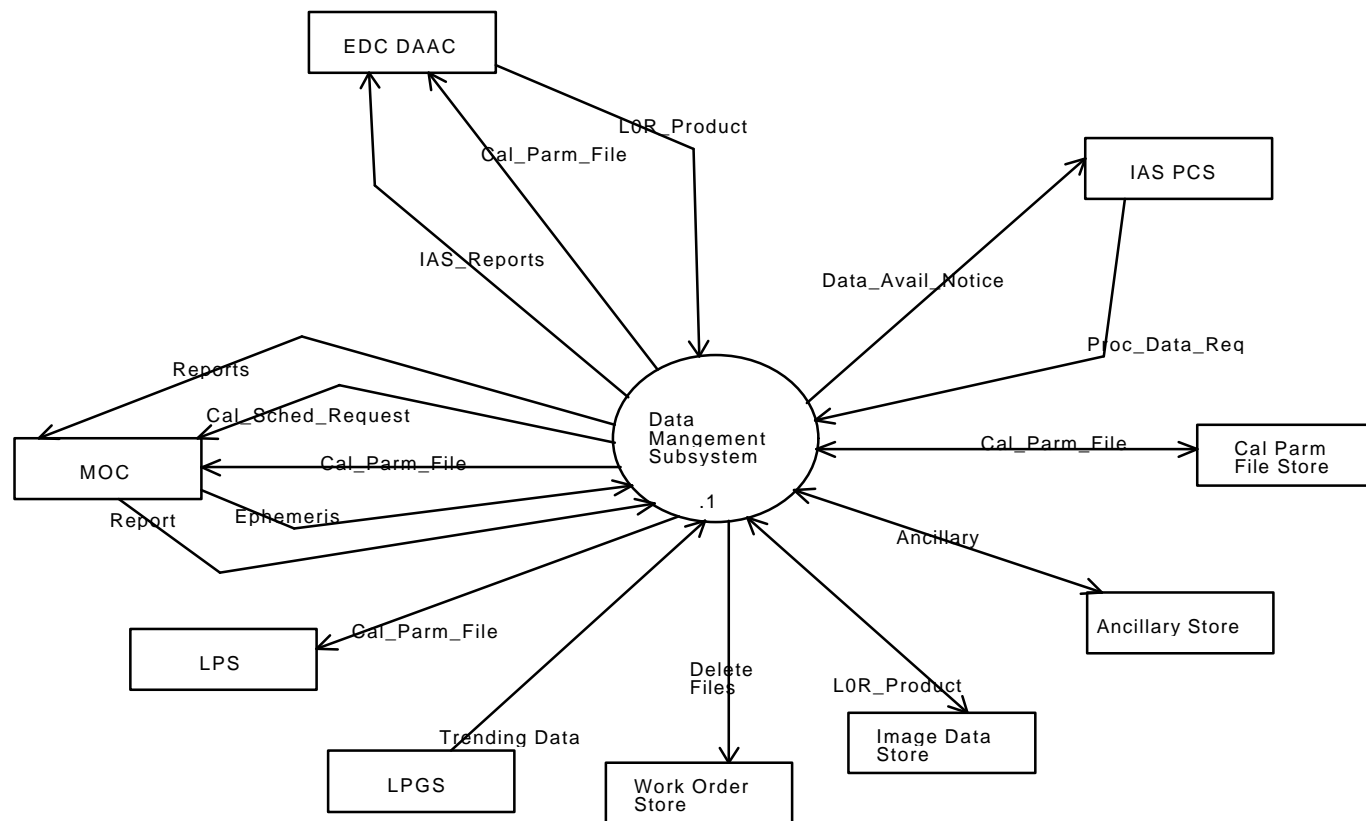
**Evaluation &
Analysis**

Database

IAS Critical Design Review

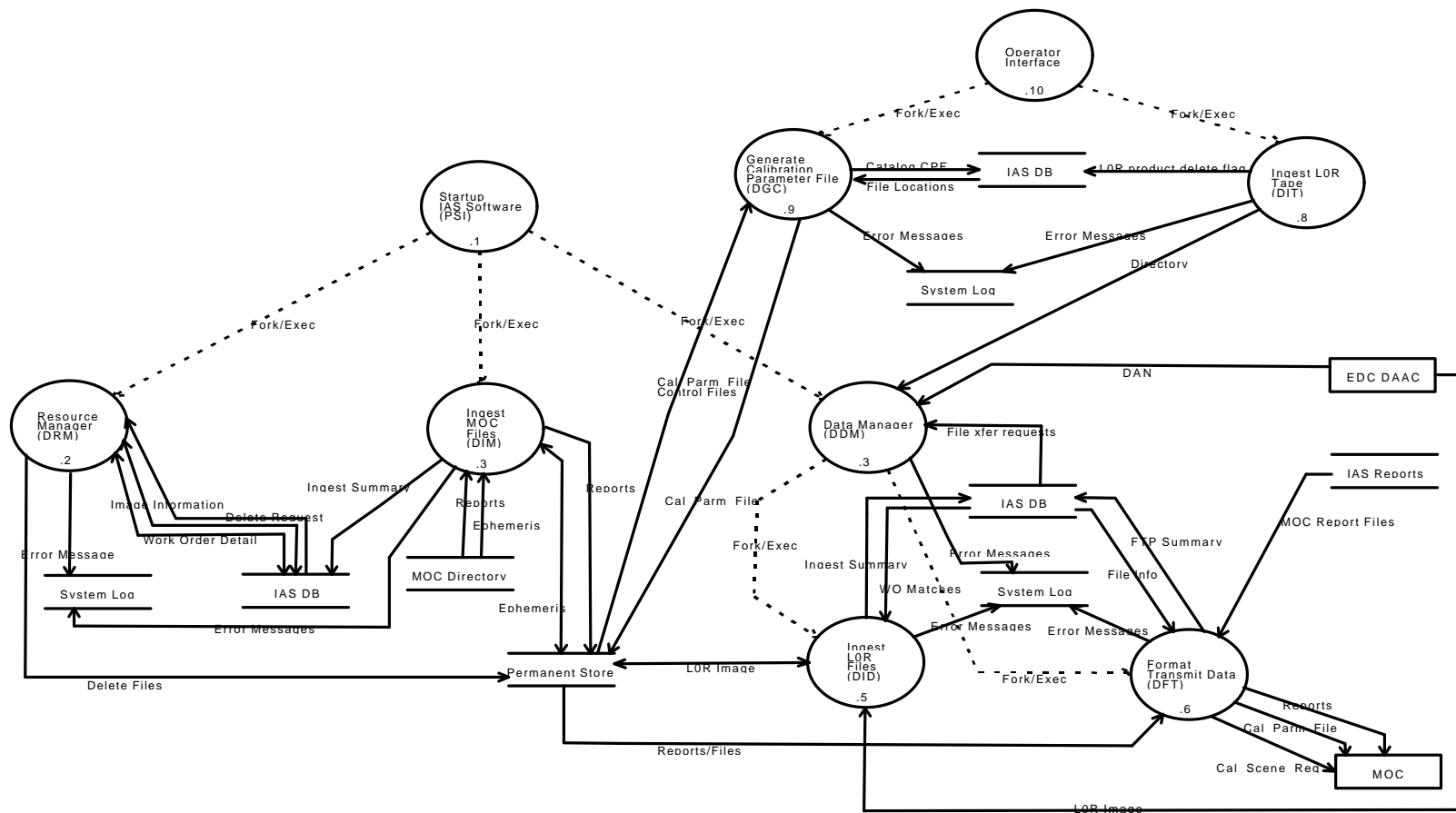


DMS Context Diagram



IAS Critical Design Review

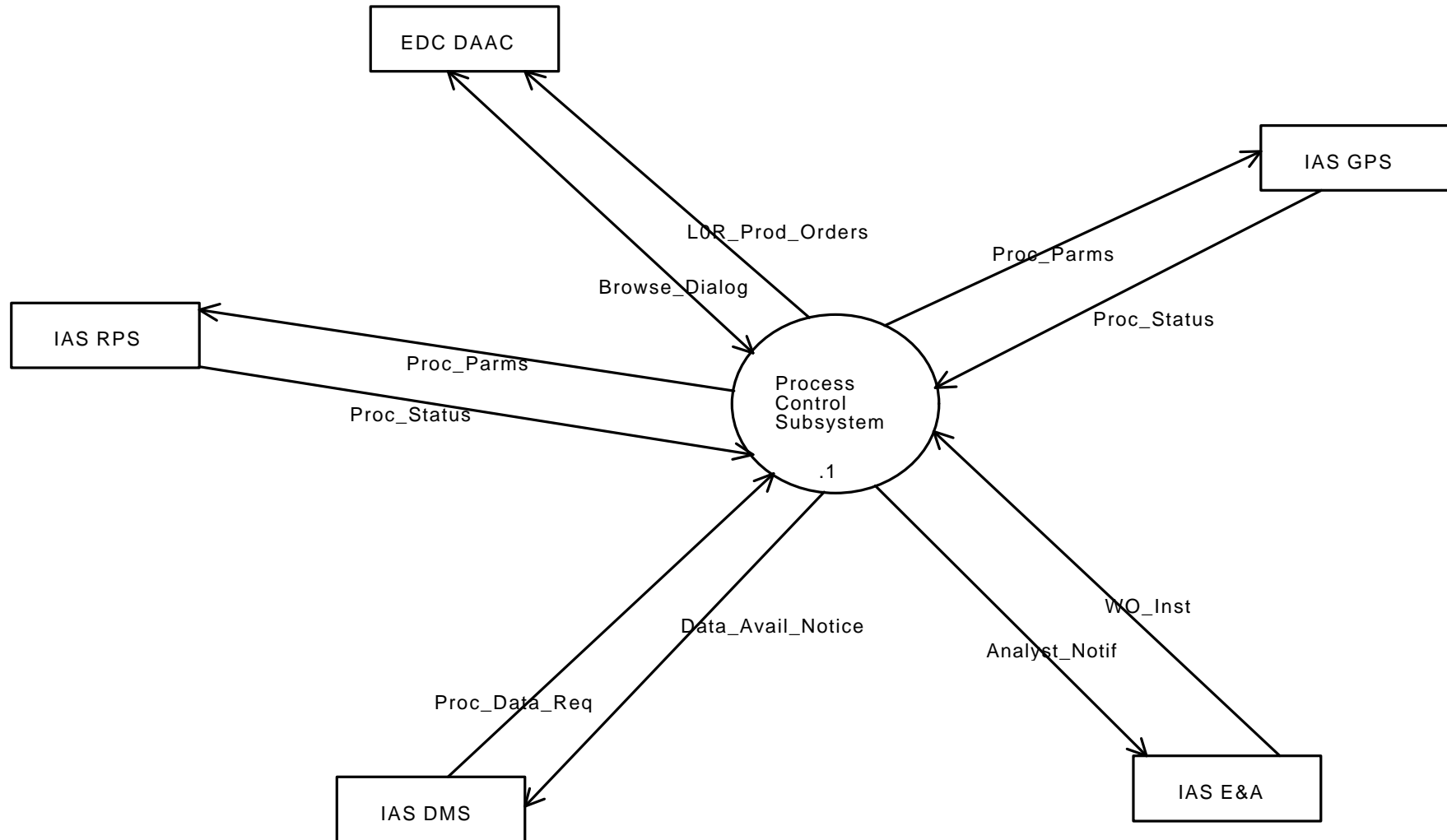
DMS Task Model



IAS Critical Design Review



PCS Context Diagram



IAS Critical Design Review



DMS and PCS Tasks

- **Resource Manager (DRM)**
 - Monitor disk usage and delete expired work orders and LOR products
- **Ingest MOC Files (DIM)**
 - Process files (ephemeris, reports) received from MOC
- **Data Manager (DDM)**
 - Start child task to process an LOR DAN or file xfer request
- **Ingest LOR Files (DID)**
 - Retrieve LOR product from DAAC and ingest
- **Format Transmit Data (DFT)**
 - Transfer files (CPF, reports) to MOC
- **Generate Cal. Param. File (DGC)**
 - Merge RPS/GPS CPF updates into baseline CPF
- **Ingest LOR Tape (DIT)**
 - Start LOR ingest by sending (via socket) a simulated DAAC DAN to DDM task
- **Startup IAS Software (PSI)**
 - Startup and monitor IAS daemon tasks (PWS, DDM, DRM, DIM)
- **Work Order Scheduler (PWS)**
 - Start a work order when all work order inputs are available
- **Work Order Controller (PWC)**
 - Build work order execution environment
 - Start and monitor each work order script

IAS Critical Design Review



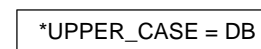
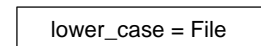
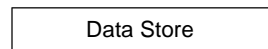
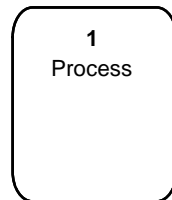
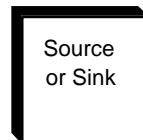
Operational Data Flow Scenarios

- **INPUT**
 - Scenario 1: Order L0R from DAAC
 - Scenario 2: Ingest L0R from DAAC
 - Scenario 3: Ingest Ephemeris and Reports from MOC
- **PROCESS**
 - Scenario 4: Setup/Start a Work Order
 - Scenario 5: Setup/Start a Work Order Script
 - Scenario 6: Assess Work Order Results; Mark WO for Deletion
 - Scenario 7: Delete Work Order and L0R; Archive Work Order
- **OUTPUT**
 - Scenario 8: Build CPF; Transfer Report/CPF to MOC
 - Scenario 9: Transfer Report/CPF to DAAC
- **SYSTEM**
 - Scenario 10: IAS Software Error/Status Reporting
 - Scenario 11: IAS Startup
 - Scenario 12: IAS Shutdown

IAS Critical Design Review



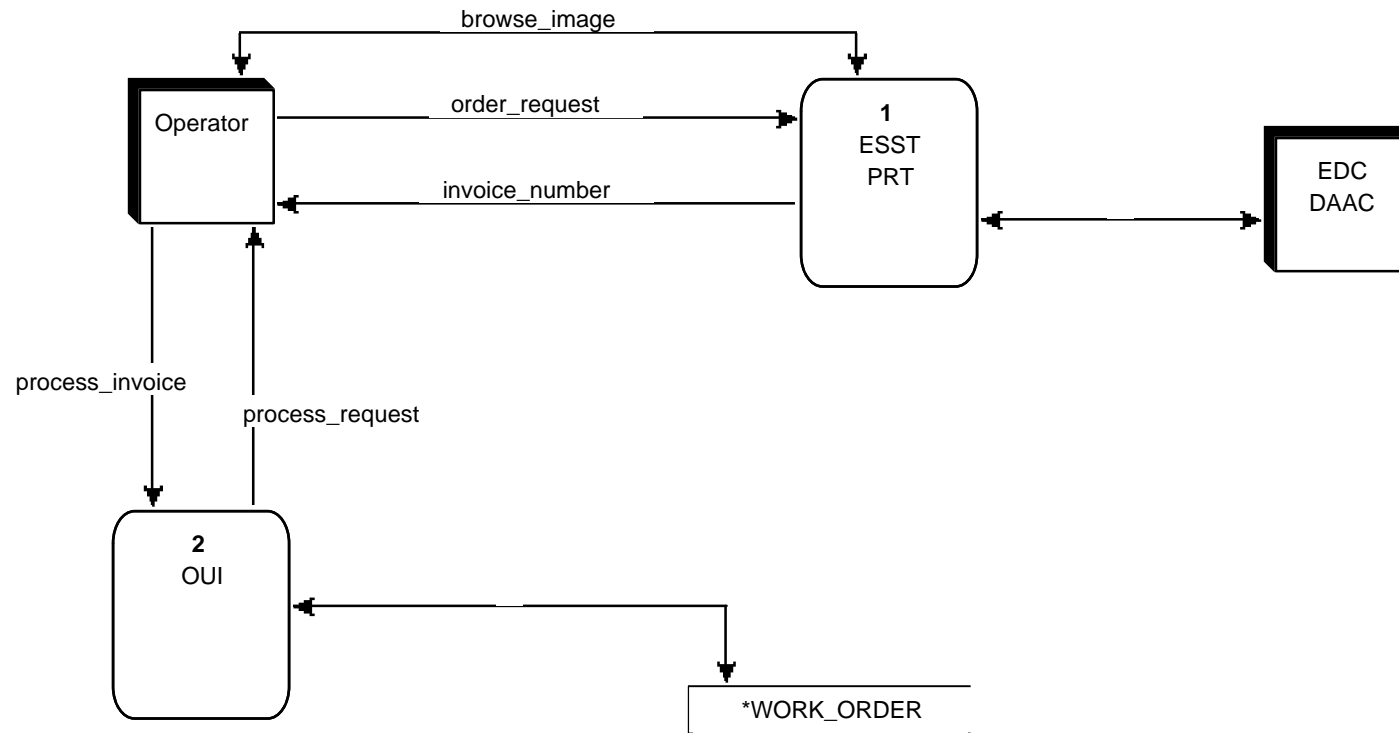
Operations Flow Diagram Symbols



IAS Critical Design Review

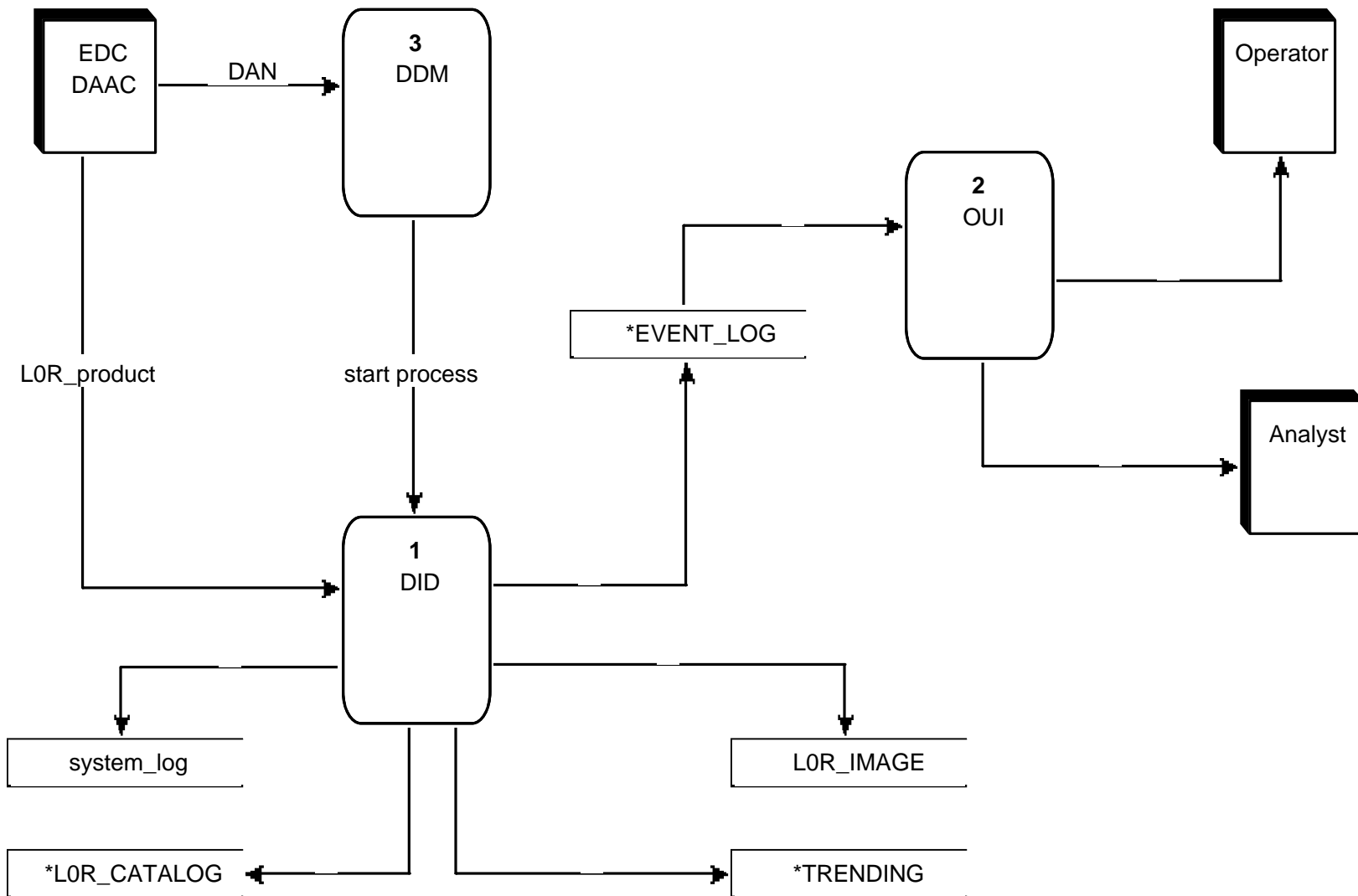


Order L0R from DAAC



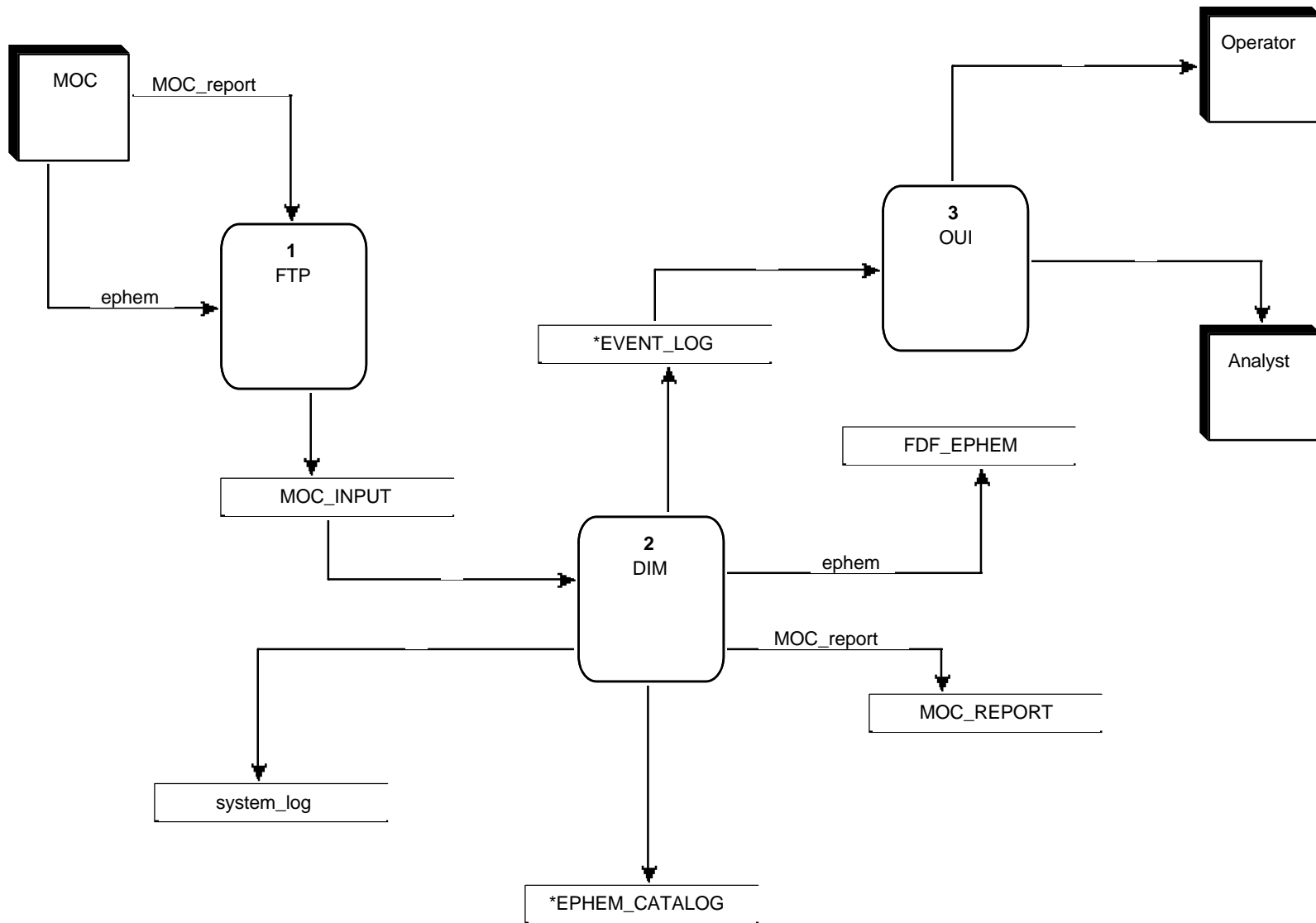


Ingest L0R from DAAC



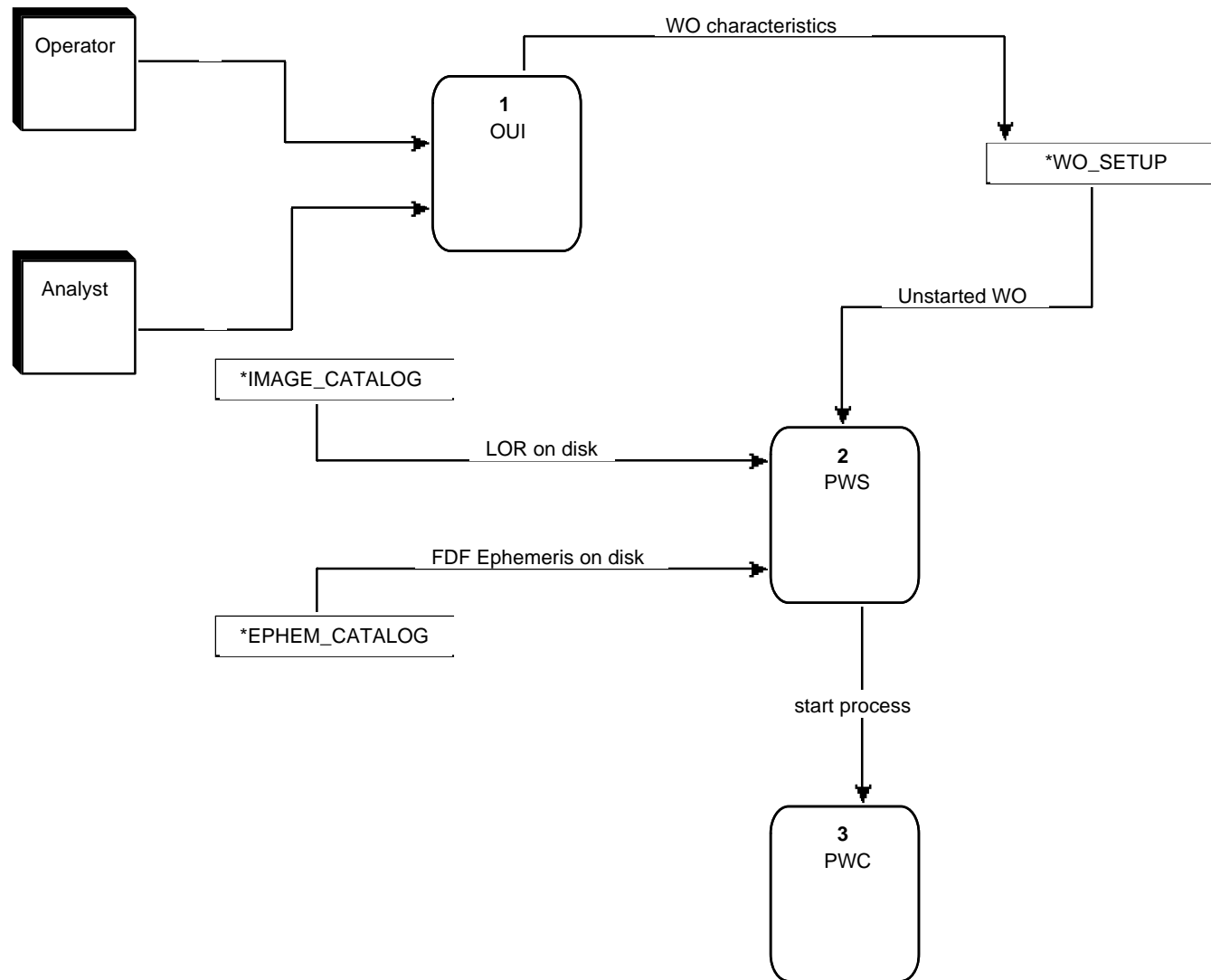


Ingest Ephemeris and Reports from MOC



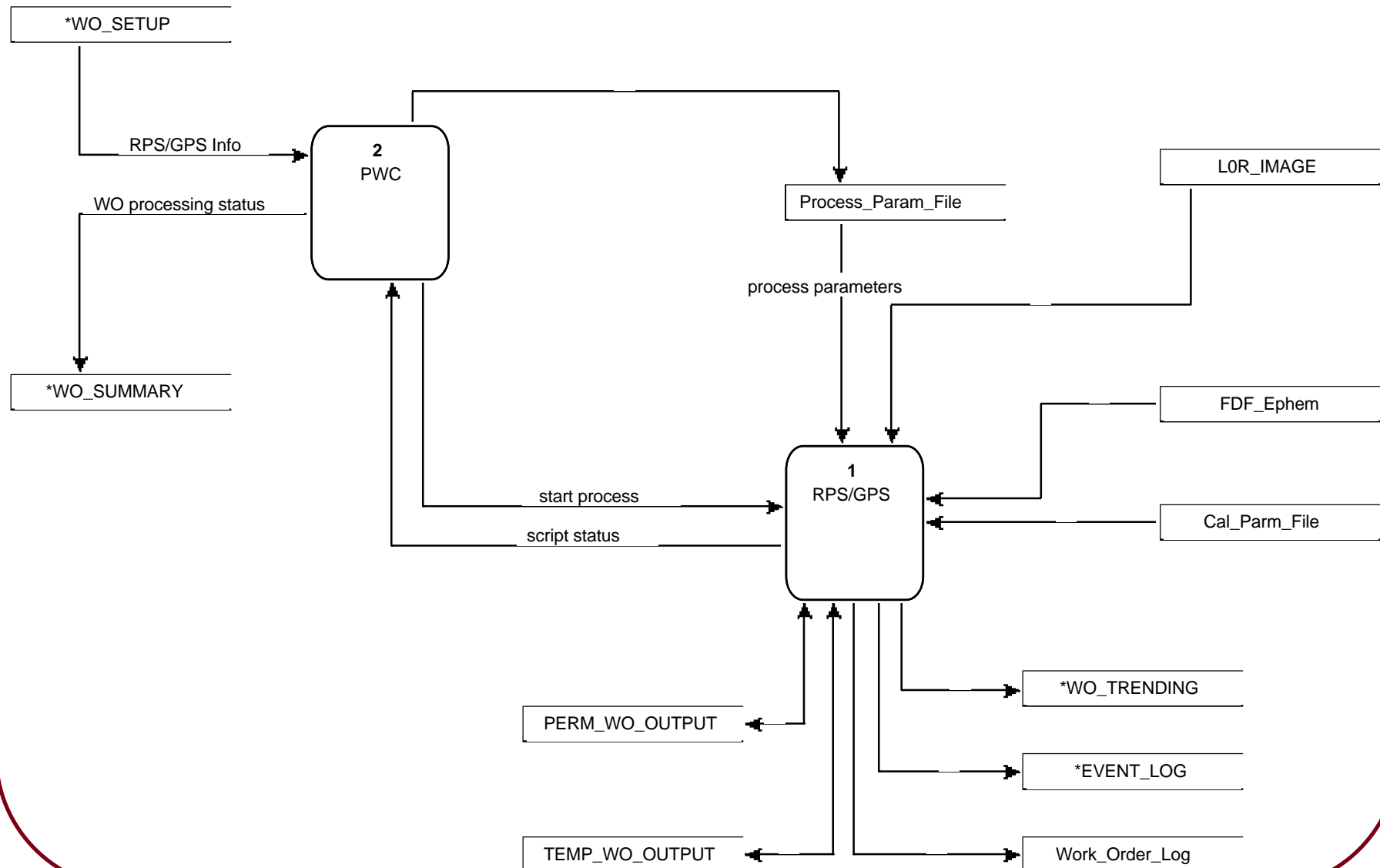
IAS Critical Design Review

Setup/Start a Work Order





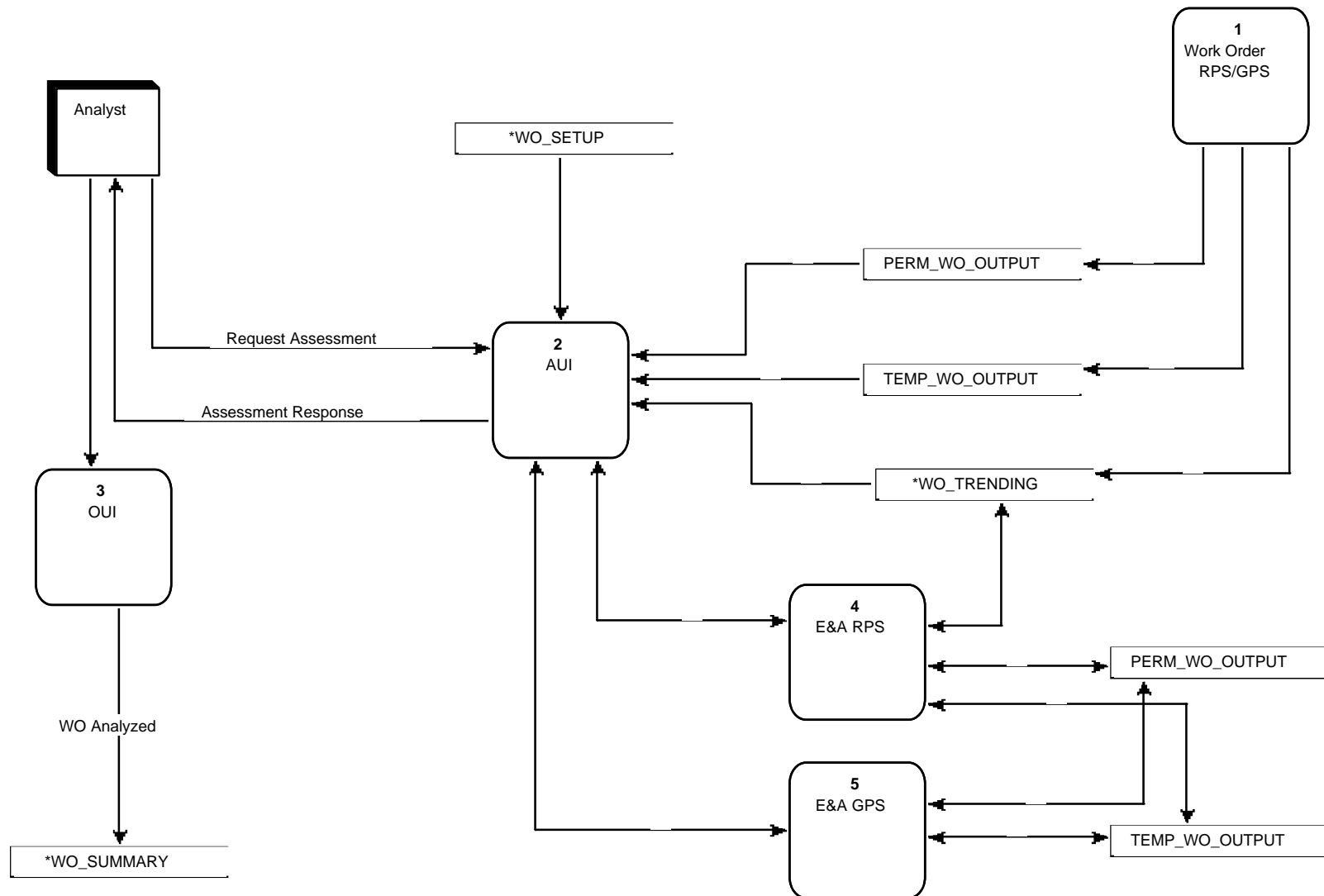
Setup/Start a Work Order Script



IAS Critical Design Review

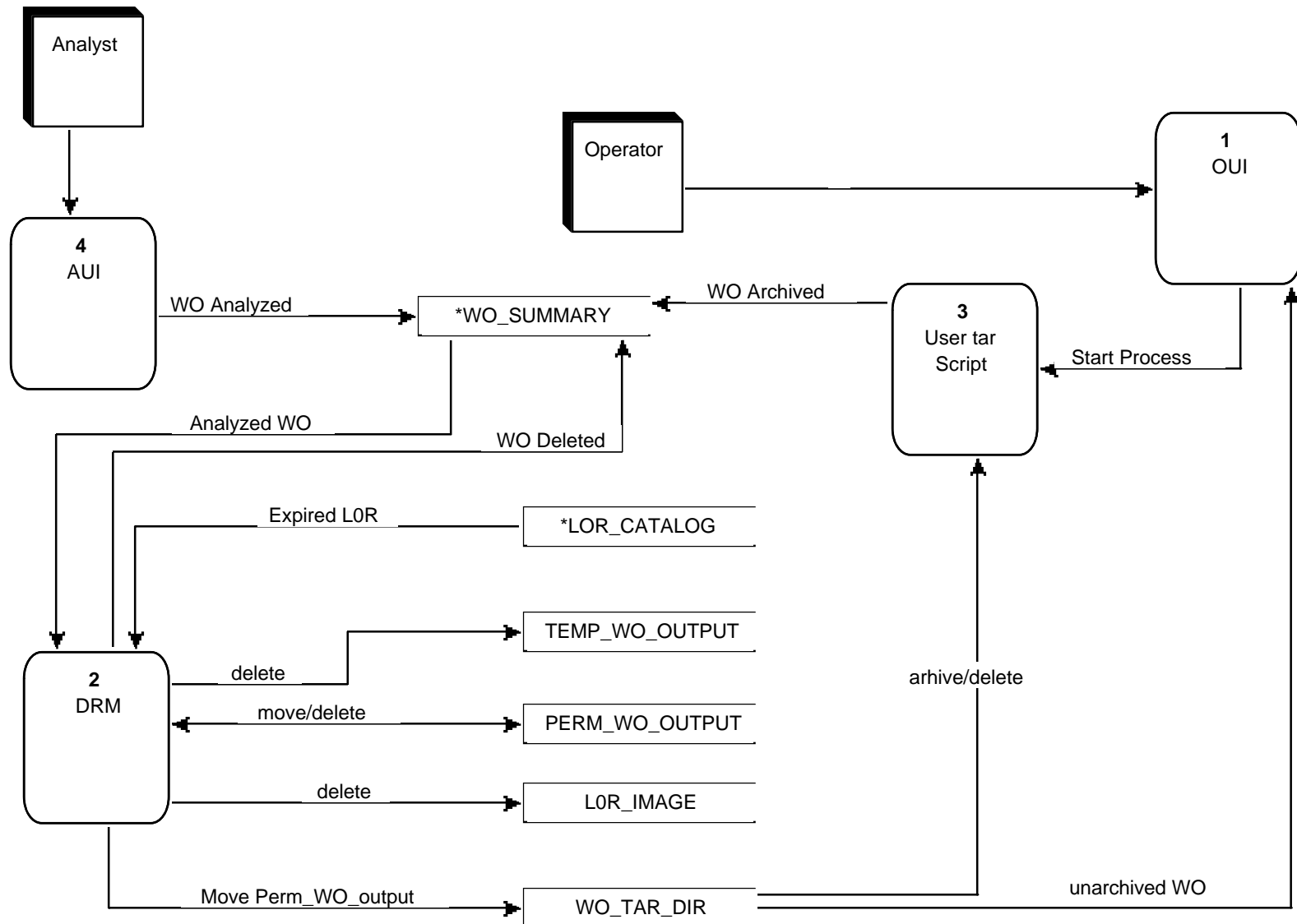


Assess Work Order Results; Mark WO for Deletion





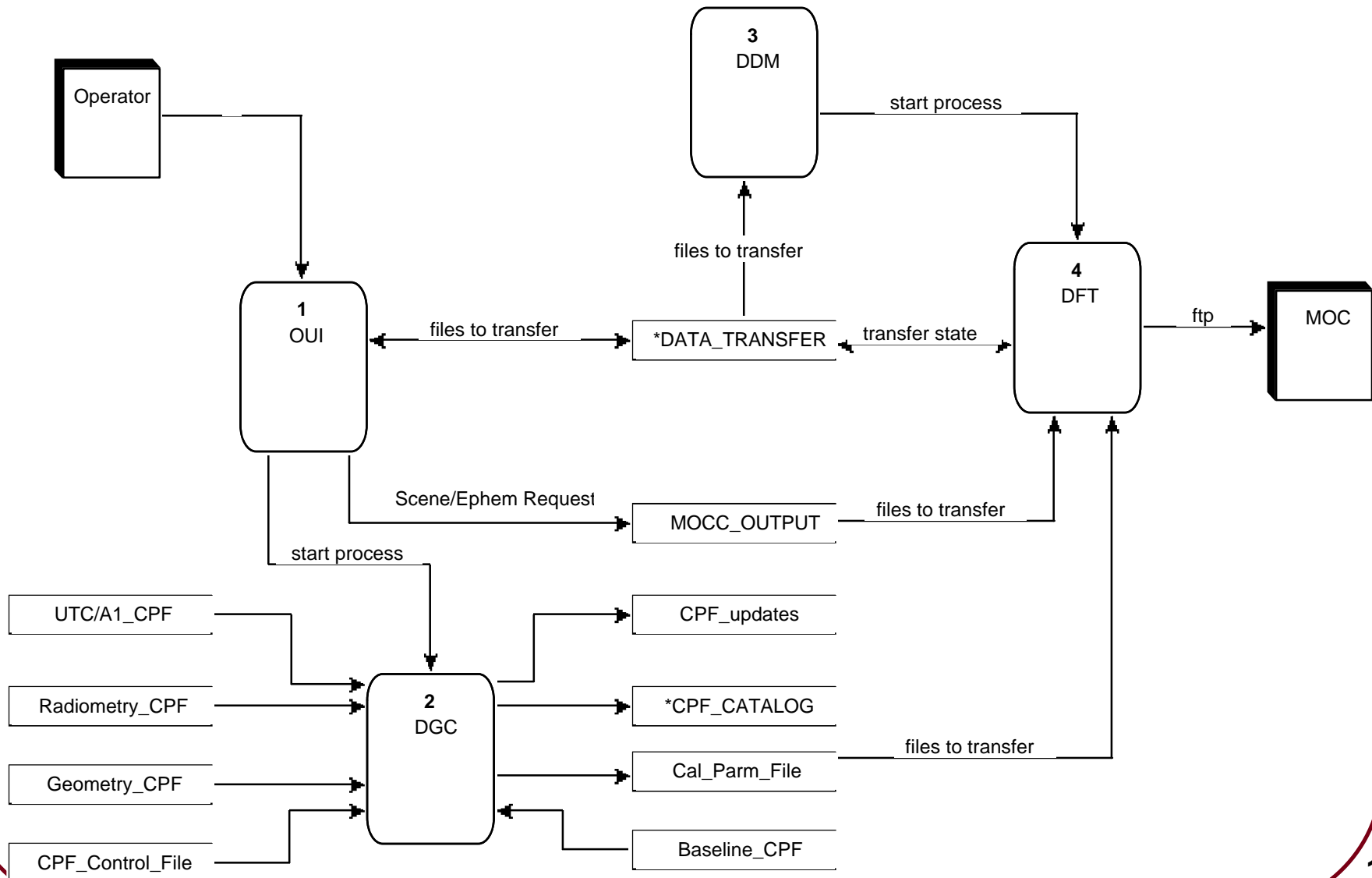
Delete Work Order and LOR; Archive Work Order



IAS Critical Design Review

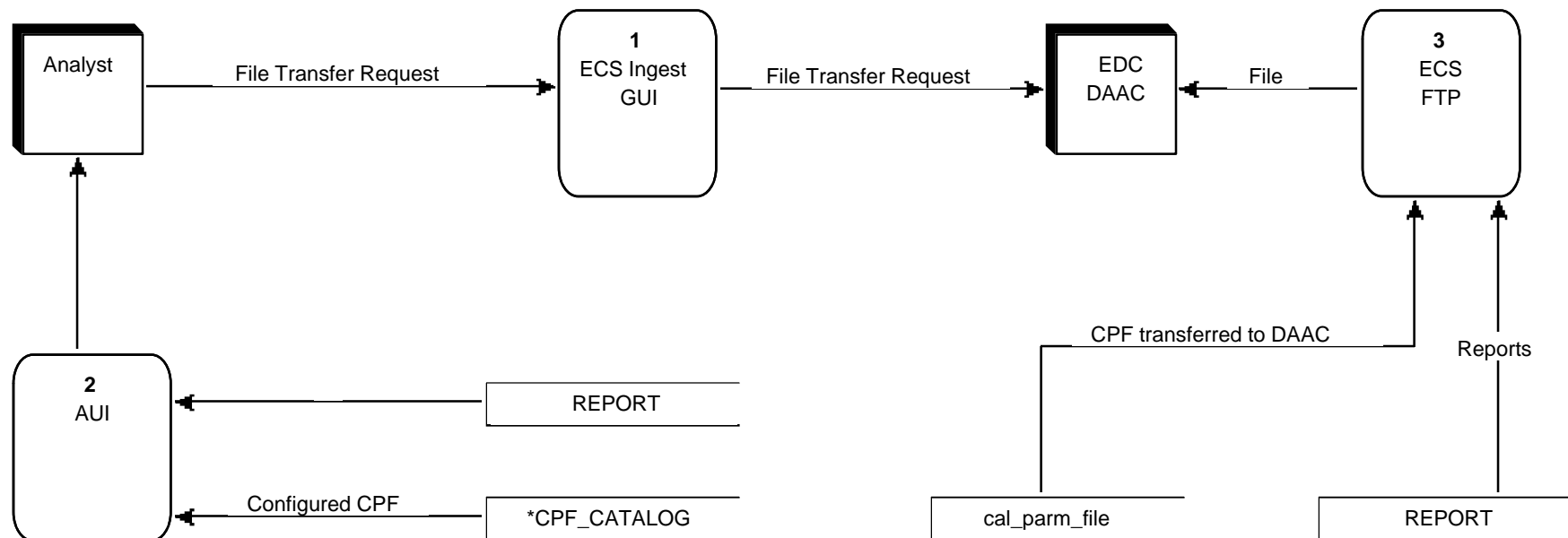


Build CPF; Transfer Report/CPF to MOC



IAS Critical Design Review

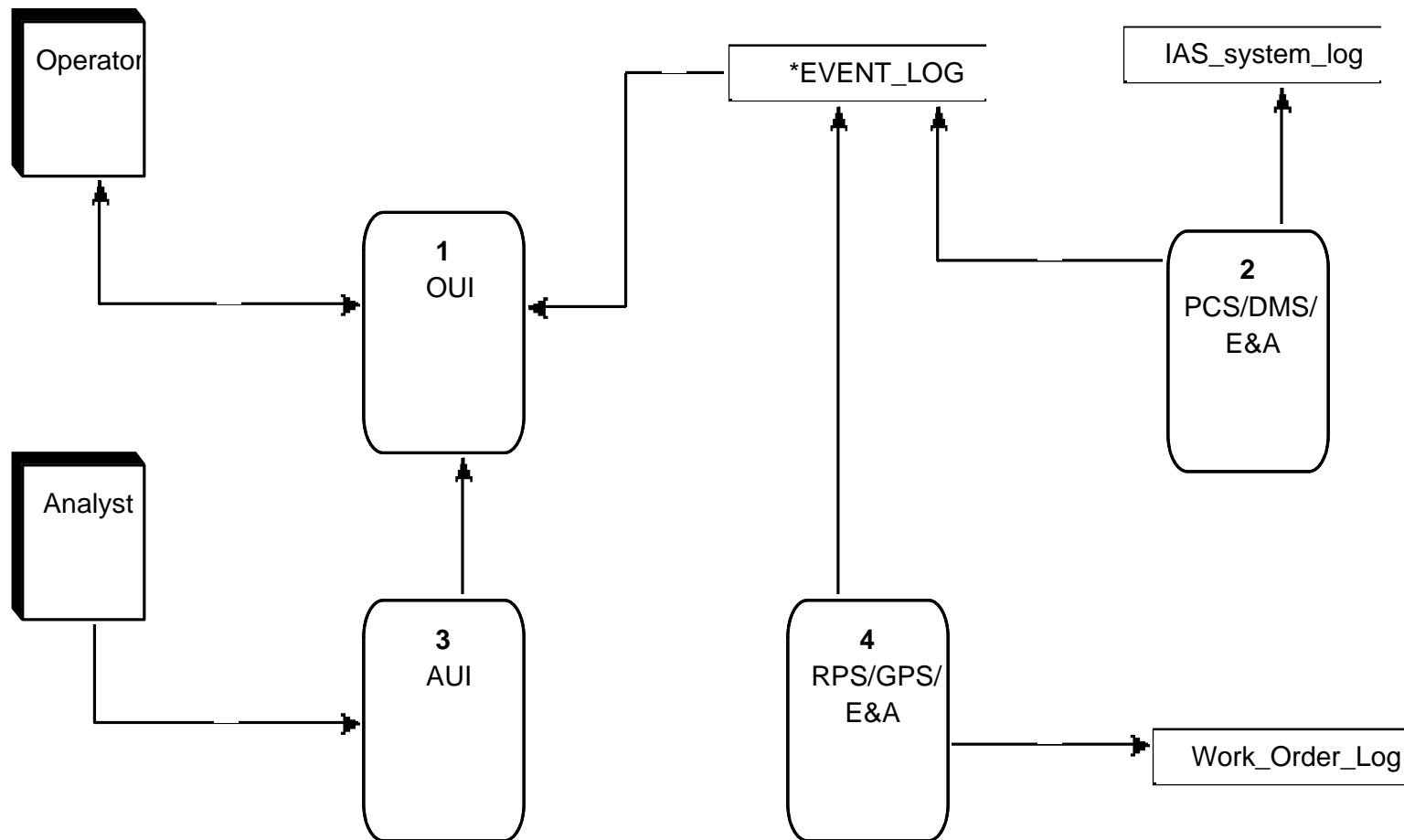
Transfer Report/CPF to DAAC



IAS Critical Design Review



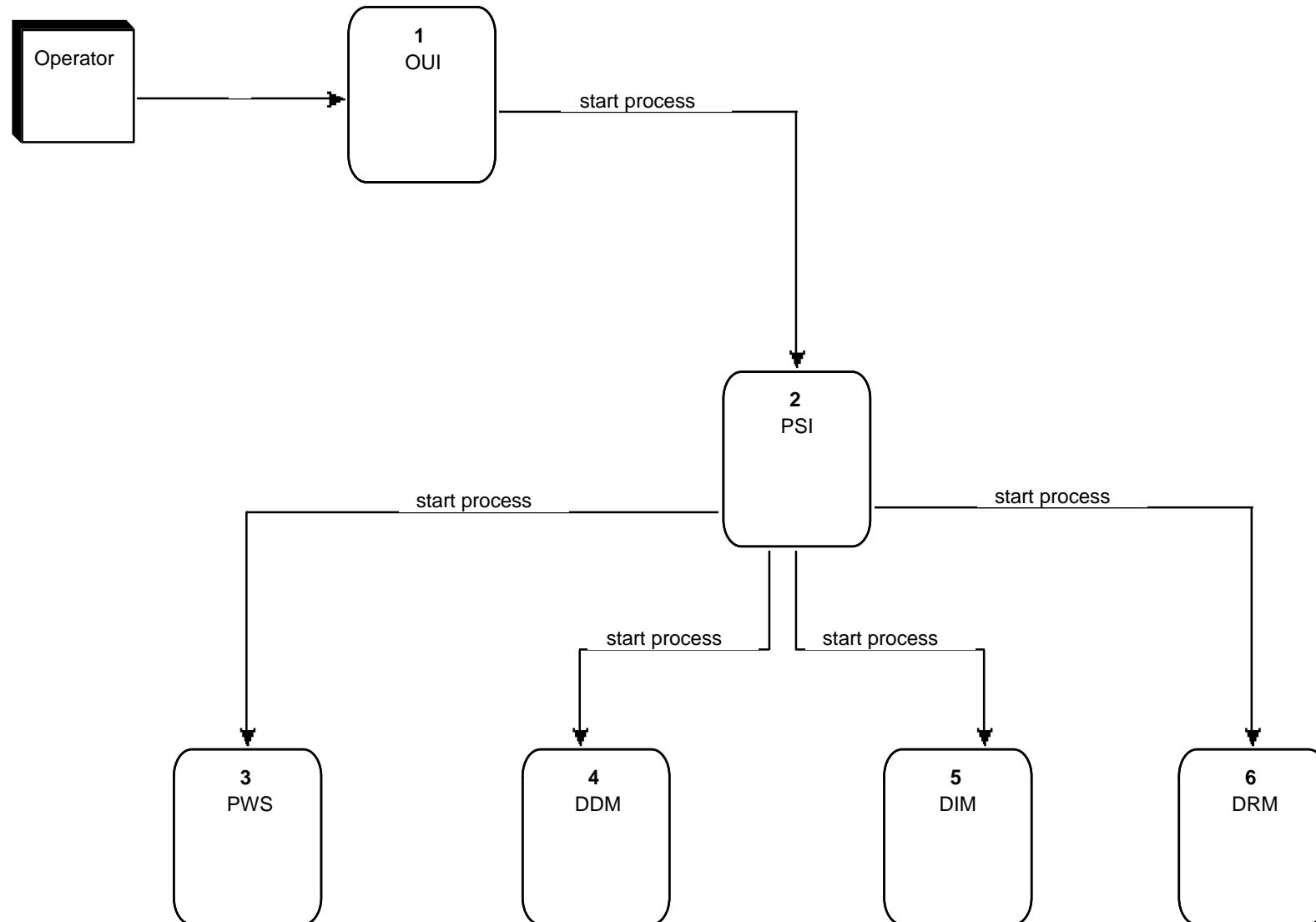
IAS Software Error/Status Reporting



IAS Critical Design Review



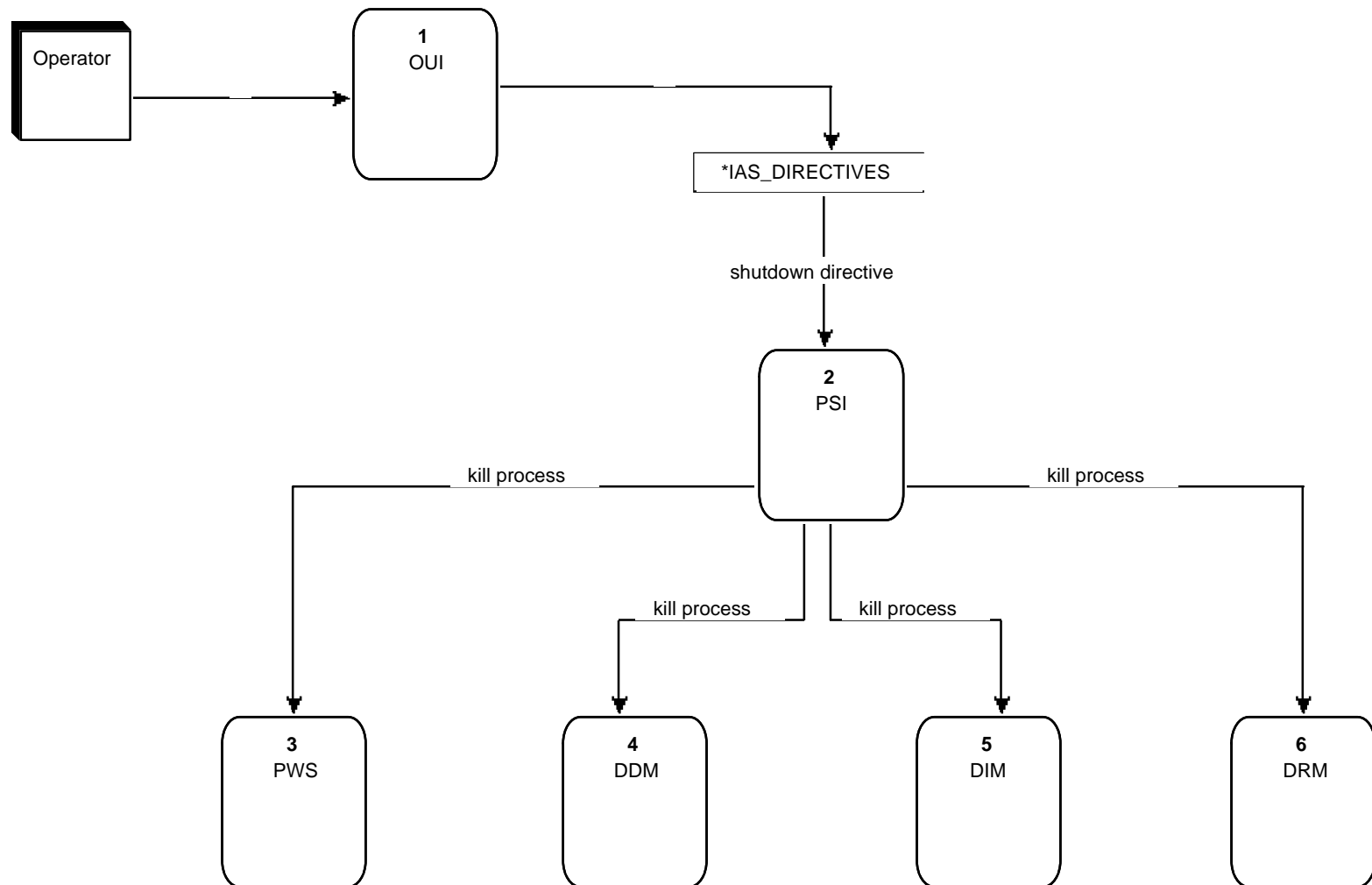
IAS Startup



IAS Critical Design Review



IAS Shutdown





Interactive Interface

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

A. Williard

Database



- **IAS Detailed Design Specification documents database schema design**
- **Personnel from all IAS subsystems reviewed schema design**
- **Database provides major role in IAS processing:**
 - **Assists in anomaly resolution by maintaining IAS processing history**
 - **Primary means of inter-process communication**
 - **Maintains data for:**
 - **Trending**
 - **Work Order Setup**
 - **LOR Statistics**

IAS Critical Design Review



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Interactive Interface

J. Storey

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

Database

IAS Critical Design Review



Purpose of the RPS

- **Provide an IAS Analyst with the data and tools needed to maintain the radiometric calibration parameters - most importantly the gains and biases used to convert digital numbers to absolute radiance - in the Calibration Parameter File**
 - **Provide the capability to calibrate the absolute radiometric response of each detector to an accuracy of 5%**
 - **Provide the capability to calibrate the relative radiometric response between detectors to within 2%**
- **Process data from 3 onboard calibration sources and integrate the results**
 - **Internal Calibrator**
 - **Partial Aperture Solar Calibrator**
 - **Full Aperture Solar Calibrator**



Purpose of the RPS

- **Characterize Level 0R data quality and assess the presence of various image artifacts**
- **Characterize the radiometric performance of individual ETM+ detectors**
- **Generate Level 1R images, correcting artifacts and converting pixels to absolute radiance**
- **Generate processing reports**
- **Generate parameters for ETM+ performance trending**



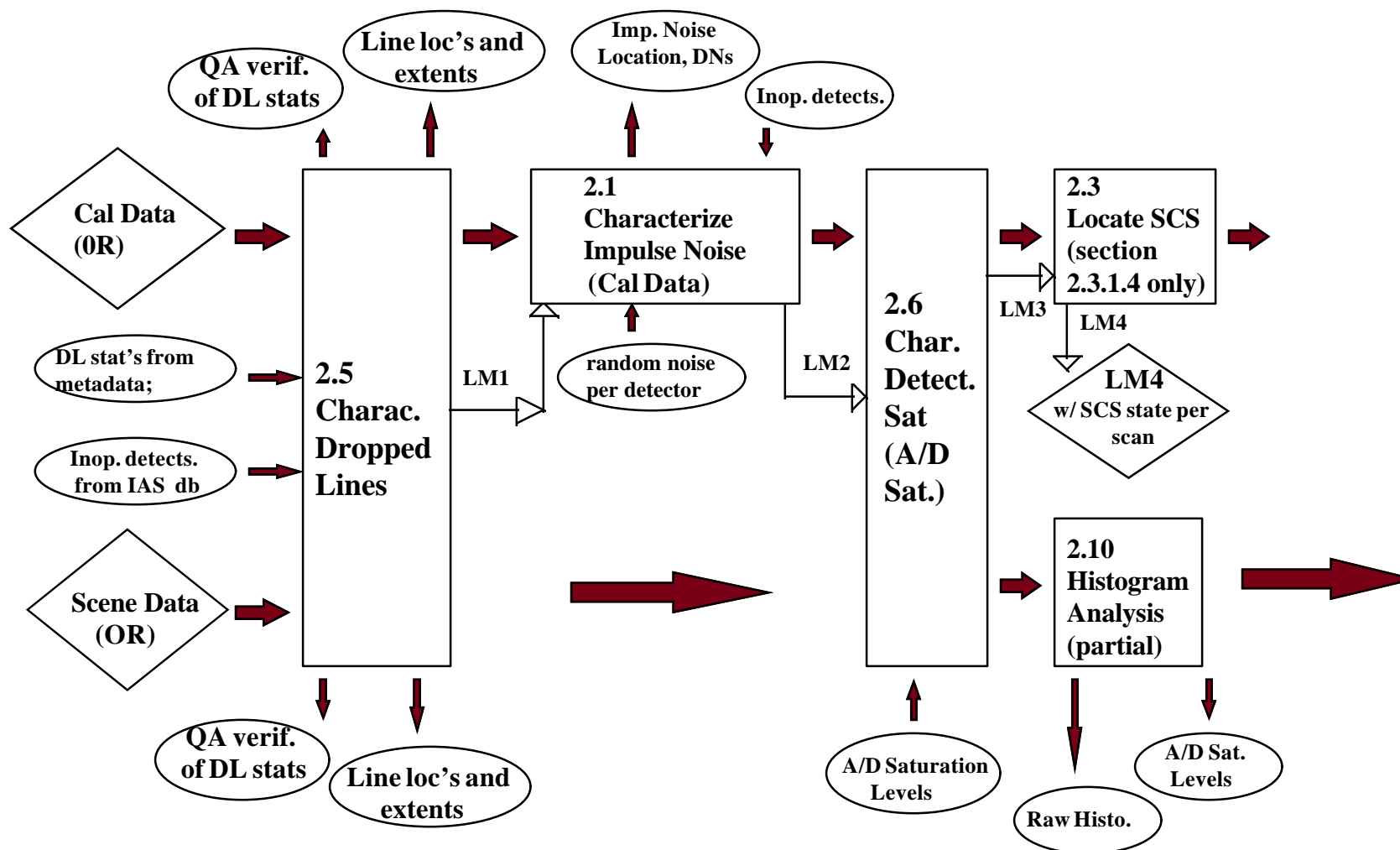
Radiometric Processing Characteristics

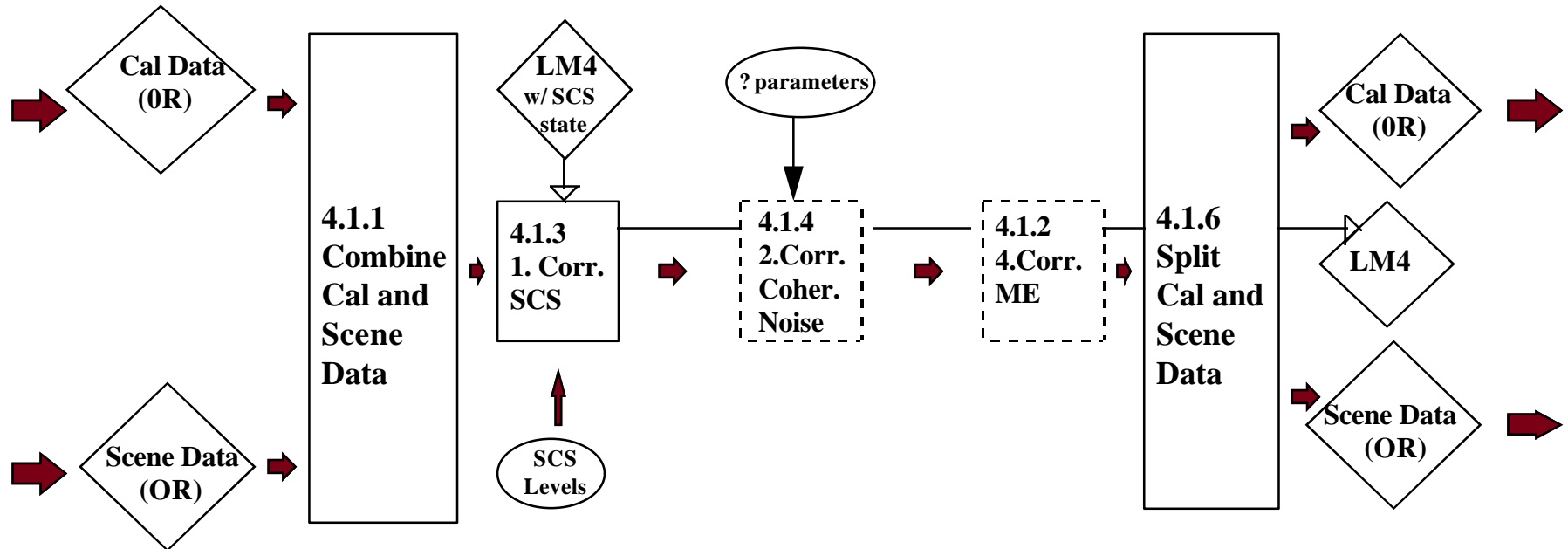
- **Approximately 35 radiometric algorithms are implemented in RPS**
- **Algorithms generally fall into 2 categories - characterizations and corrections**
 - **Characterizations derive from a statistical analysis of IC and scene data**
 - **Instrument performance characterizations derive from an analysis of scenes of largely uniform content (IC, FASC, PASC)**
- **Algorithms are executed in a fixed sequence defined by the Landsat-7 Project Science Office**
- **Algorithms that can be executed vary with the type of scene being processed (day, night, PASC, or FASC)**
- **User options can further restrict the execution of specific characterizations or corrections**

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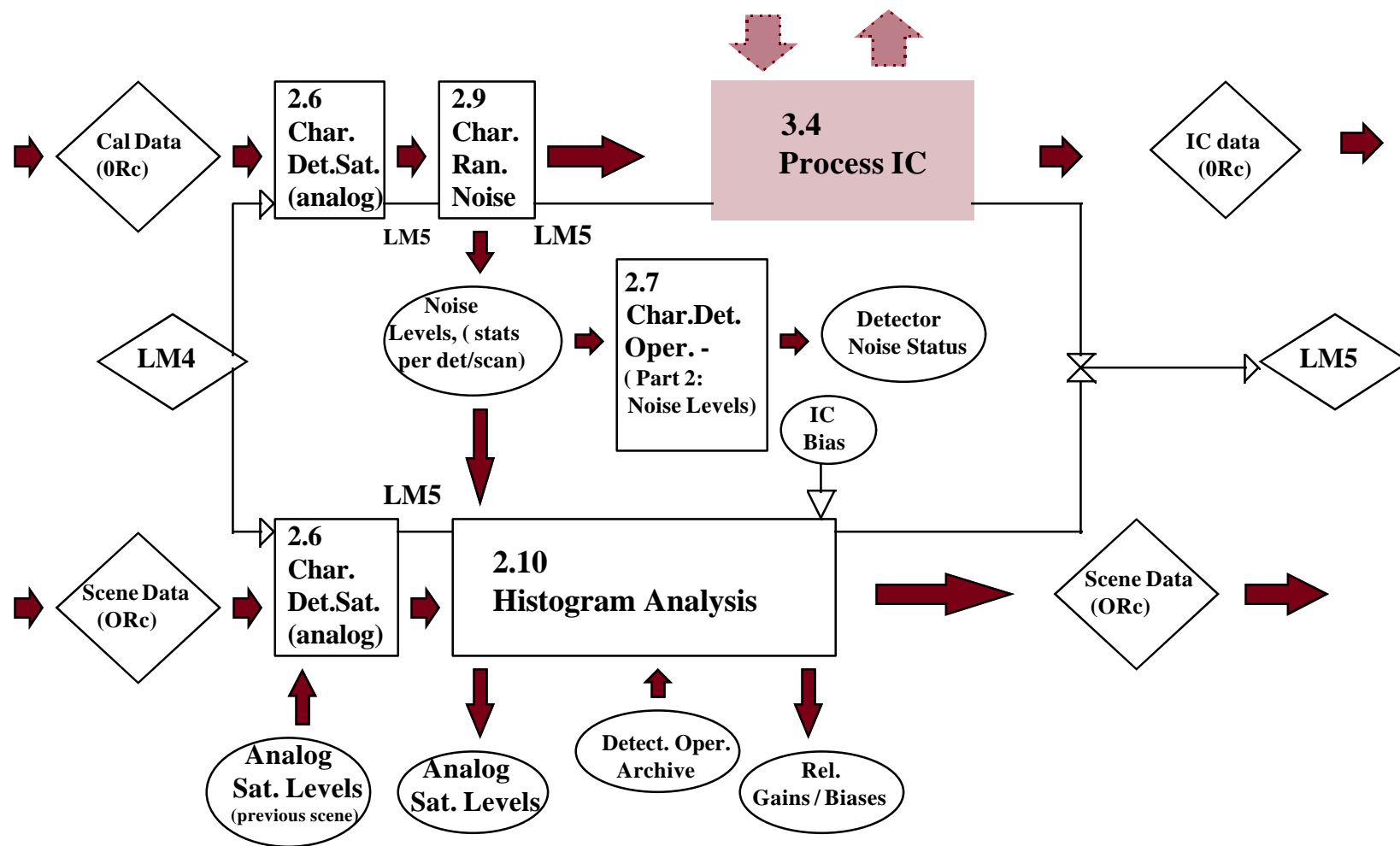
Level 0R Characterization





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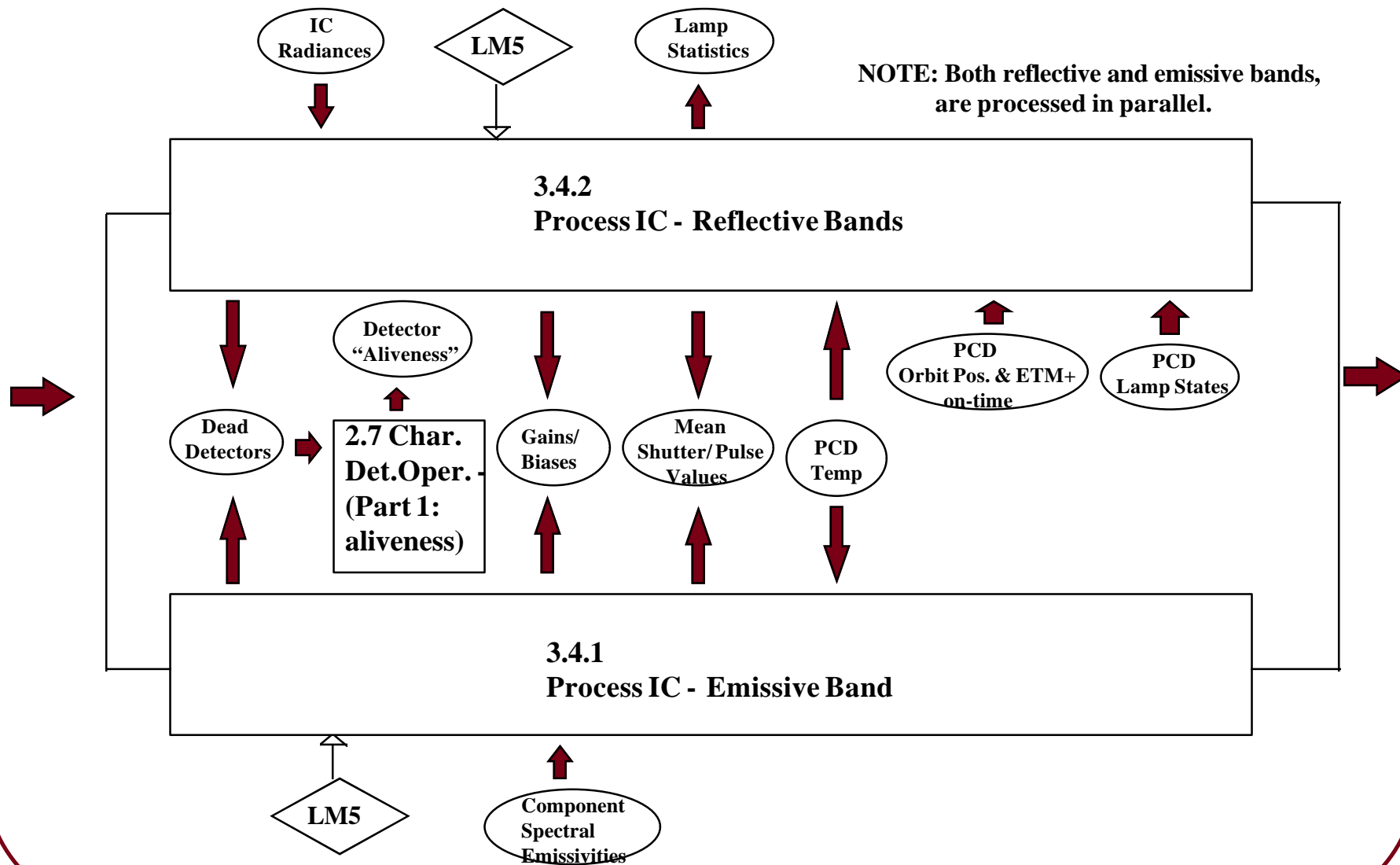
Level ORc Characterization



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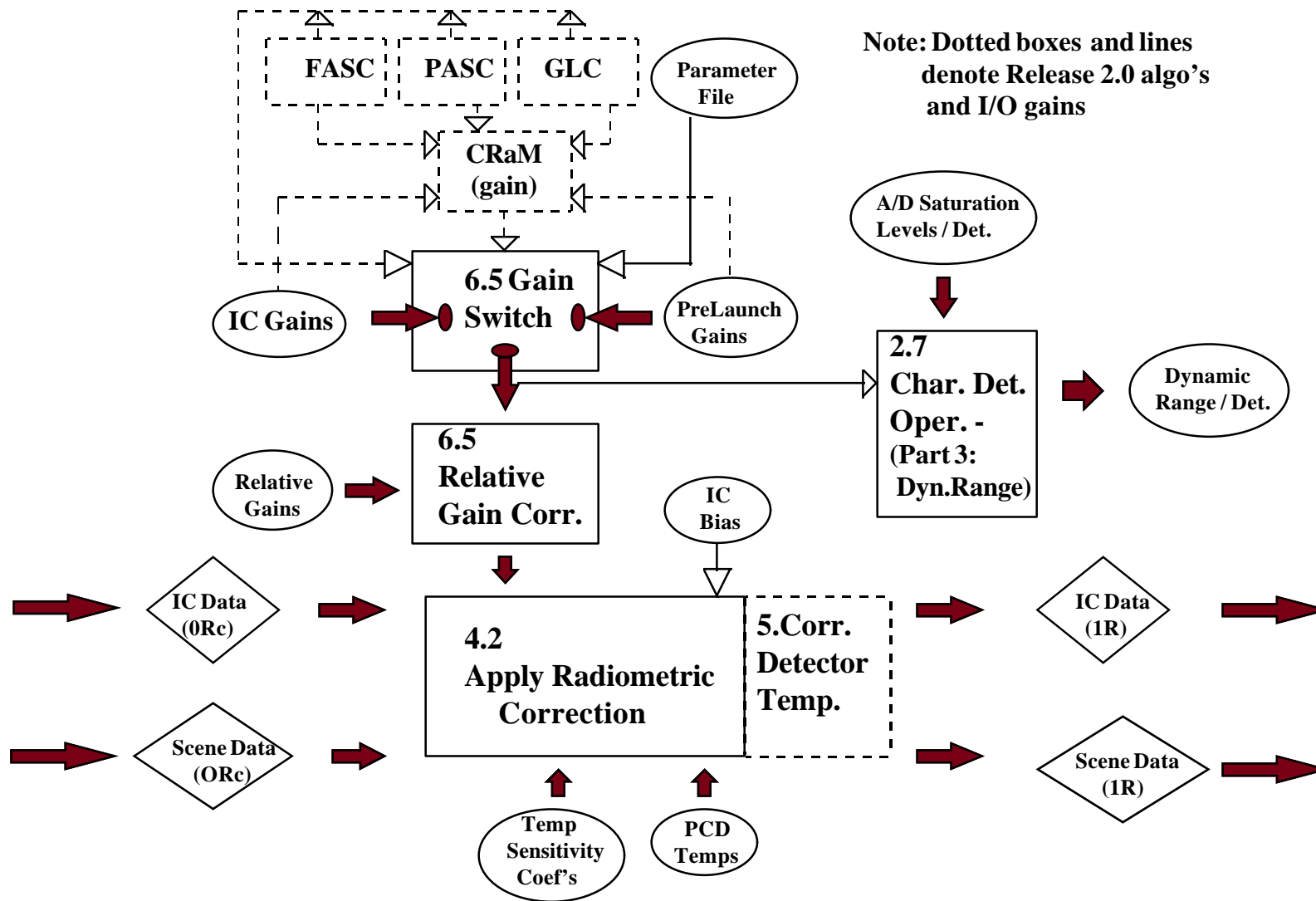


IC Processing



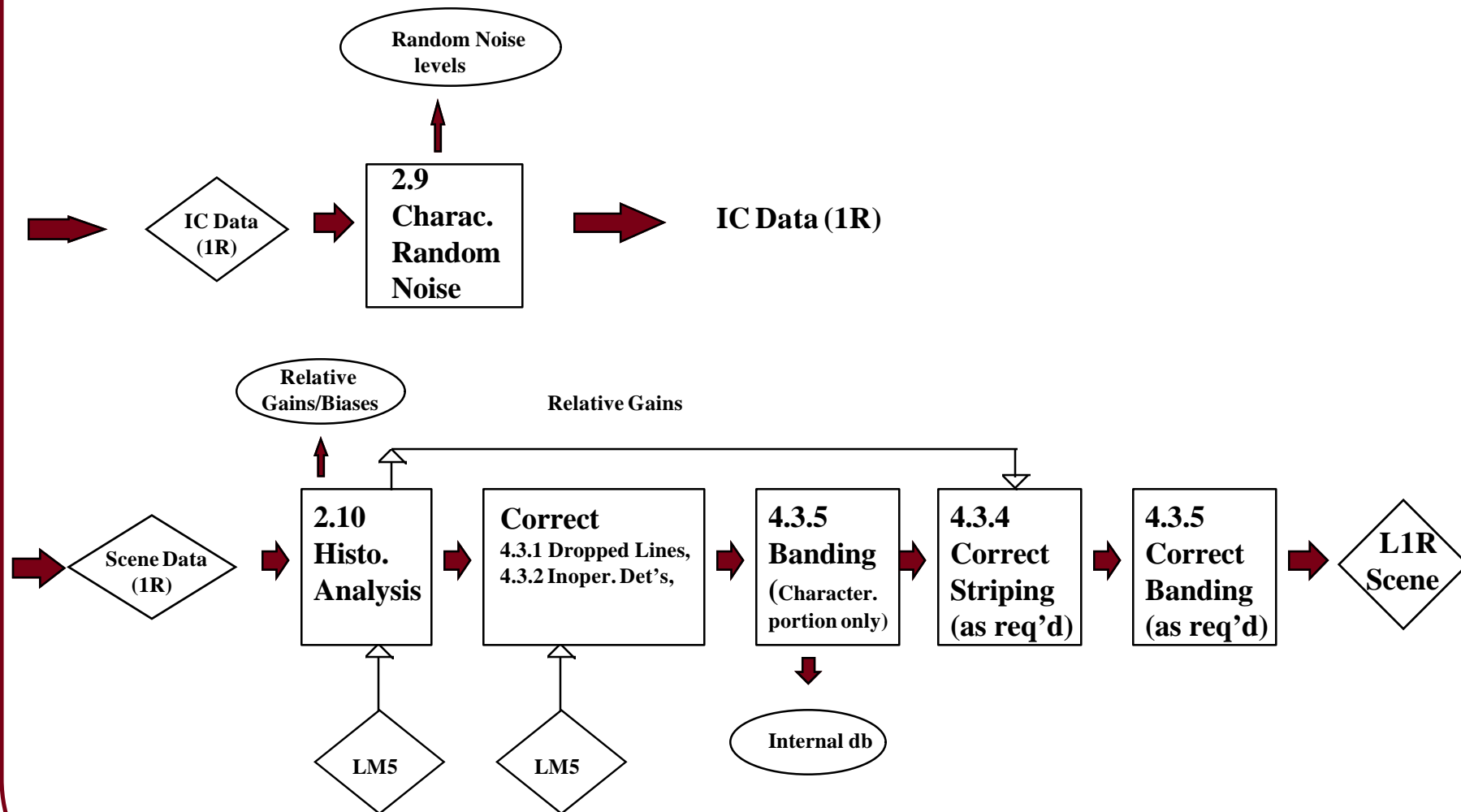
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Level 0Rc Correction





Level 1R Characterization and Correction



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RPS Operations Overview



- **Through the Operator or Analyst User Interface, an IAS user inputs a Work Order specifying:**
 - **scene-id, scene type, bands to process, and Calibration Parameter File to be used**
 - **which characterizations and corrections are to be executed**
 - **break points for review of intermediate results**
- **Data Management Subsystem stages the specified input files**
- **Process Control Subsystem initiates RPS tasks in sequence**
- **RPS tasks perform requested characterizations and corrections, generating corrected images, reports, and trending data**
- **RPS notifies user at the completion of task execution that processing results are available for review**
- **The user then reviews the processing results and performs ad hoc analyses using tools provided in the Evaluation and Analysis (E&A) subsystem**

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RPS Design Considerations



- **Need to break up the total processing flow into reasonably-sized tasks to permit easier maintenance and to allow for checking of intermediate results**
- **Desire to easily modify the order in which algorithms are executed**
- **Large volumes of data are being processed. Need to minimize I/O.**
 - **Level 0R (byte image) is 450 MB (IC and image, all bands)**
 - **Level 0Rc (FP) is 1.8 GB**
 - **Level 1R (I2) is 900 MB**
- **Need to design the 1R processing components for maximum reuse by LPGS**

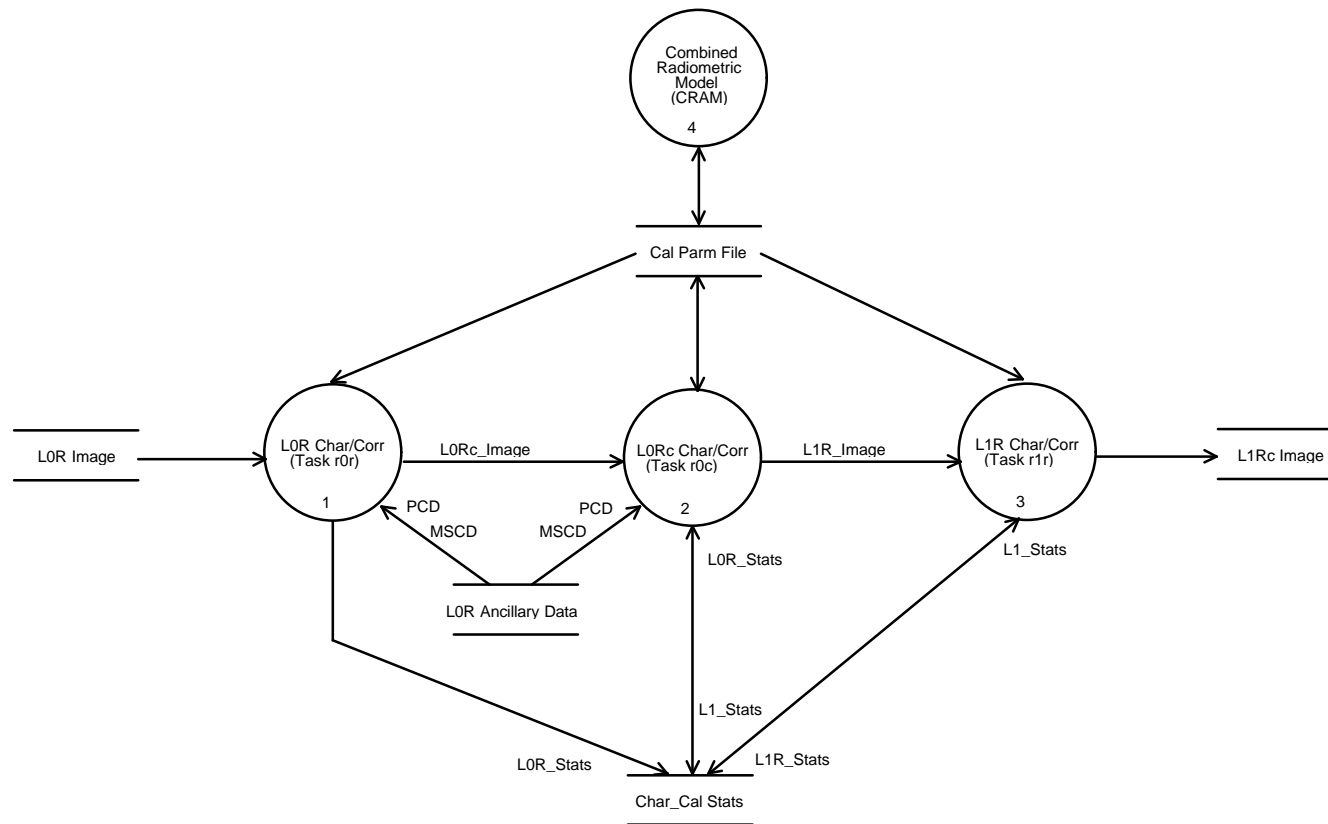


RPS Software Design/Operations Features

- **Organized into 3 major inline and several offline (E&A) applications.**
- **The major inline applications are split at points where intermediate images (0Rc and 1R) are generated**
- **Each application contains “sub-drivers” that control the order of algorithm execution. These are easily modified to change the order of algorithm execution.**
- **RPS processes one image band at a time. To minimize I/O, the entire band is read into memory and accessed there by the algorithms.**
- **Subinterval image files are split along scene boundaries and processed. The results are combined, where necessary, in E&A.**

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RPS Level 0 Task Diagram





RPS Tasks

- **Level 0R Characterization and Correction (Task r0r)**
 - **Processes the Level 0R product ingested from the DAAC**
 - **Identifies the locations of pixels that need to be ignored in downstream statistical analyses - missing minor frames, impulse noise, saturated detectors, scan-correlated shift**
 - **Performs additional characterizations - coherent noise, memory effect, and scan-correlated shift - when processing night or FASC scenes**
 - **Corrects the Level 0R image for coherent noise, memory effect, scan-correlated shift**
 - **Outputs corrected Level 0R image (L0Rc)**



RPS Tasks

- **Level 0Rc Characterization and Correction (Task r0c)**
 - **Processes IC data to characterize random noise and A/D saturation**
 - **Assesses detector performance characteristics (e.g., SNR)**
 - **Generates gains and biases by analyzing scene content (IC, FASC, and PASC)**
 - **Radiometrically corrects scene data by applying gains and biases from a user-specified source**
 - **Outputs radiometrically corrected Level 1R image (L1R)**



RPS Tasks

- **Level 1R Characterization and Correction (Task r1r)**
 - Cosmetically corrects 1R image. Corrects for missing minor frames, inoperable detectors, saturated detectors, striping, and banding
 - Generates Level 1Rc image
- **Combined Radiometric Model (Task CRaM)**
 - Performs statistical comparison of calibration results from all calibration sources
 - Integrates the results from all calibration sources into an “optimal” calibration solution



Radiometric Evaluation and Analysis (E&A)

- Radiometric applications generate text reports and plots as well as trending data that are stored in the IAS Oracle database
- Once algorithm execution has completed, the Analyst is alerted that results are available for review
- Text reports and plots are viewed using utilities invoked from the E&A User Interface
- E&A will provide the user interface to canned database queries needed to generate the trending displays specified in the algorithm descriptions
- Free form database queries will also be supported
- Generic image processing capabilities (image display and manipulation) will be provided via ENVI and IDL

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RPS Design and Review Status

- **RPS Detailed Design (Structure Charts and MSpecs) were reviewed with the Radiometry Team 3/25 and 3/26.**
- **Approximately 4 low priority algorithms and the CRaM remain to be designed. Issues relating to these algorithms were resolved at the design walkthrough.**
- **Decisions were made at the design walkthrough to move parts of some of the algorithms out of the main inline processing flow and into E&A. The design must be updated to reflect these decisions.**

IAS Critical Design Review



Agenda

- | | |
|----------------------------------|--------------------------------|
| • Introduction | R. Schweiss |
| • Design Overview | S. Johnston |
| • Hardware Architecture | C. Brambora |
| • Operational Scenarios | S. Johnston |
| • Software Design | |
| – Overview | J. Hosler |
| – Operations Interface | J. Whelan |
| – Management and Control | A. Williard |
| – Database | A. Williard |
| – L1 Processing | |
| | J. Storey |
| – Evaluation and Analysis | D. Kaufmann/M. Schienle |
| • System Test | E. Crook |
| • Conclusion | R. Schweiss |



Software Hierarchy

Interactive Interface

J. Storey

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

Database



Geometric Processing Subsystem

- **Key Requirements**
- **Operations Concept**
 - **Work Order Processing**
 - **Level 1G Processing**
 - **Analyst Operations**
 - **Geodetic Test Sites**
 - **Geometric Super-Sites**
 - **Band-to-Band Sites**
- **Subsystem Processes**
 - **Level 1G**
 - **Geometric Characterization**
 - **Geometric Calibration**



GPS Key Requirements

- **Level 1G Processing**
 - Process PCD and MSCD to create spacecraft and sensor model
 - Create systematic (1Gs) products
 - Create precision (1Gp) and terrain corrected (1Gt) products
- **Geometric Characterization**
 - Evaluate geodetic accuracy
 - Evaluate internal geometric accuracy
 - Evaluate image-to-image registration
 - Evaluate band-to-band registration
- **Geometric Calibration**
 - Determine sensor/spacecraft misalignment
 - Characterize and update along and across scan parameters (scan mirror profiles)
 - Determine band-to-band registration parms



- **Work Order Processing**
 - **L1G Procedures and Scripts**
 - **Char/Cal Procedures**
 - **Geometric Super-Site Example**
- **Analyst Operations**
 - **Geodetic Test Site**
 - **Geodetic Accuracy Assessment and Alignment Calibration**
 - **Geometric Super-Site**
 - **Image-to-Image Registration, Geometric Accuracy Assessment, and Scan Mirror Calibration**
 - **Band-to-Band Test Site**
 - **Band-to-Band Registration Assessment and Band Placement Calibration**



GPS Work Order Processing

- **L1G Procedures**
 - **Level 1G Systematic Product Generation**
 - **Level 1G Precision Product Generation**
 - **Level 1G Terrain Corrected Product Generation**
- **Char/Cal Procedures**
 - **Geodetic Characterization**
 - **Sensor Alignment Calibration**
 - **Geometric Super-Site Characterization and Calibration**
 - **Image Registration Characterization**
 - **Band-to-Band Characterization and Calibration**



Geometric Super-Site Procedure

- **Operator sets up work order**
 - **Selects Geometric Super-Site Procedure**
 - **Enters required parameters (e.g., input 0R product ID)**
 - **Verifies default parameters**
 - **Submits work order**
- **PCS manages automated processing**
 - **Model Initialization (TMINIT-PCD script)**
 - **Level 1R processing (L1R script)**
 - **Systematic Grid Generation (TMGRID-SYS script)**
 - **Systematic Pan Band Resampling (TMRESAMPLE-SYS script)**
 - **GCP Correlation (TMPRECISION-GCP script)**
- **PCS suspends work order (after TMPRECISION-GCP script)**

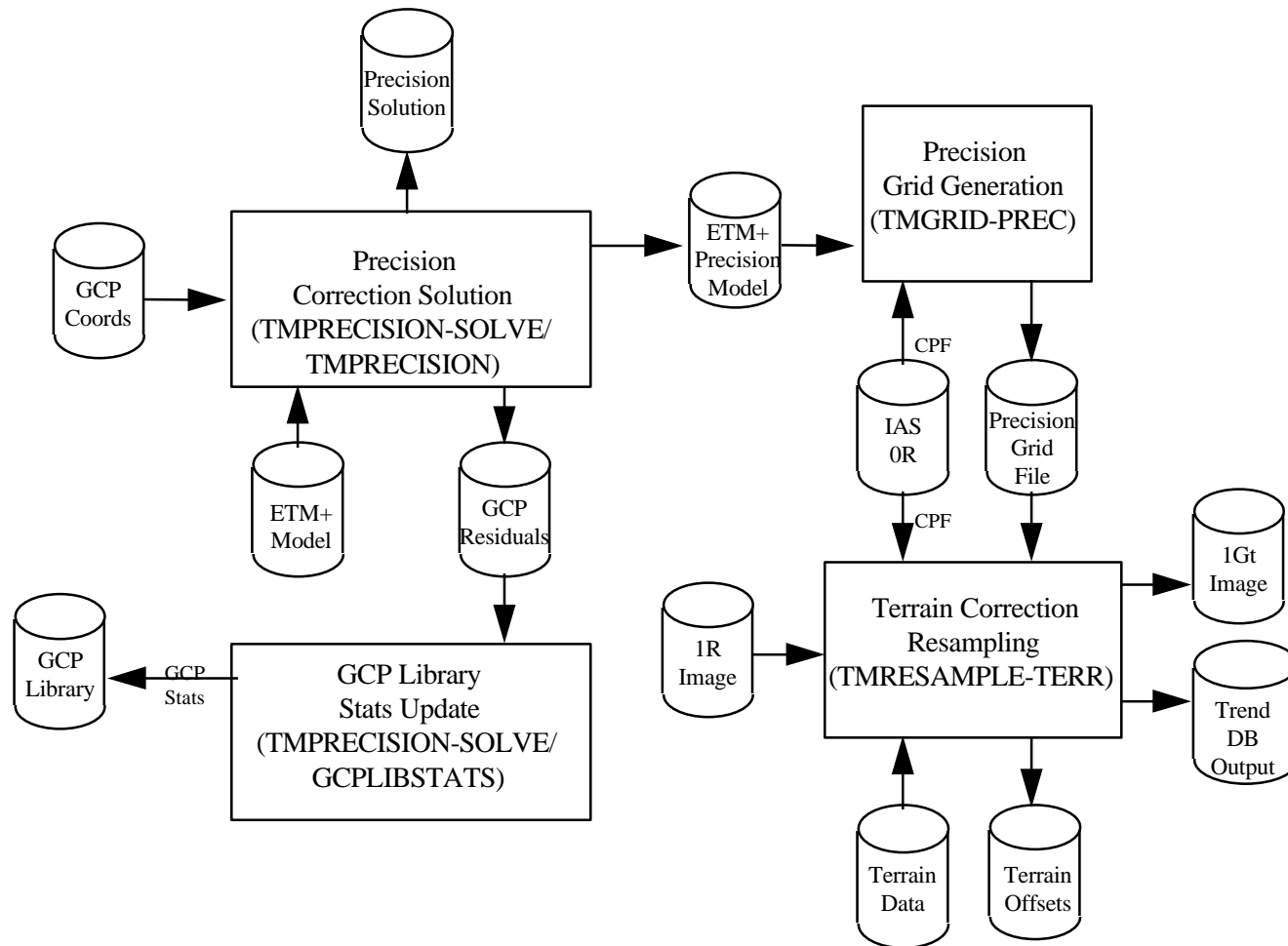


Geometric Super-Site Procedure (continued)

- The analyst manually invokes the TMPRECISION program via an IDL GUI to run the precision solution interactively
 - Reviews results of precision solution with automatic outlier rejection
 - Adjusts parameters and reruns until solution is acceptable
 - Updates work order with adjusted parameters
- PCS resumes automated processing
 - Precision solution computed using final parameters, GCP library statistics updated (TMPRECISION-SOLVE script)
 - Precision Grid Generation (TMGRID-PREC script)
 - Terrain Correction Resampling (TMRESAMPLE-TERR script)
- PCS suspends work order for analysis
- Analyst invokes IDL to run Geometric Accuracy Assessment and Scan Mirror Calibration applications
- Analyst declares work order complete after all analysis tasks are finished

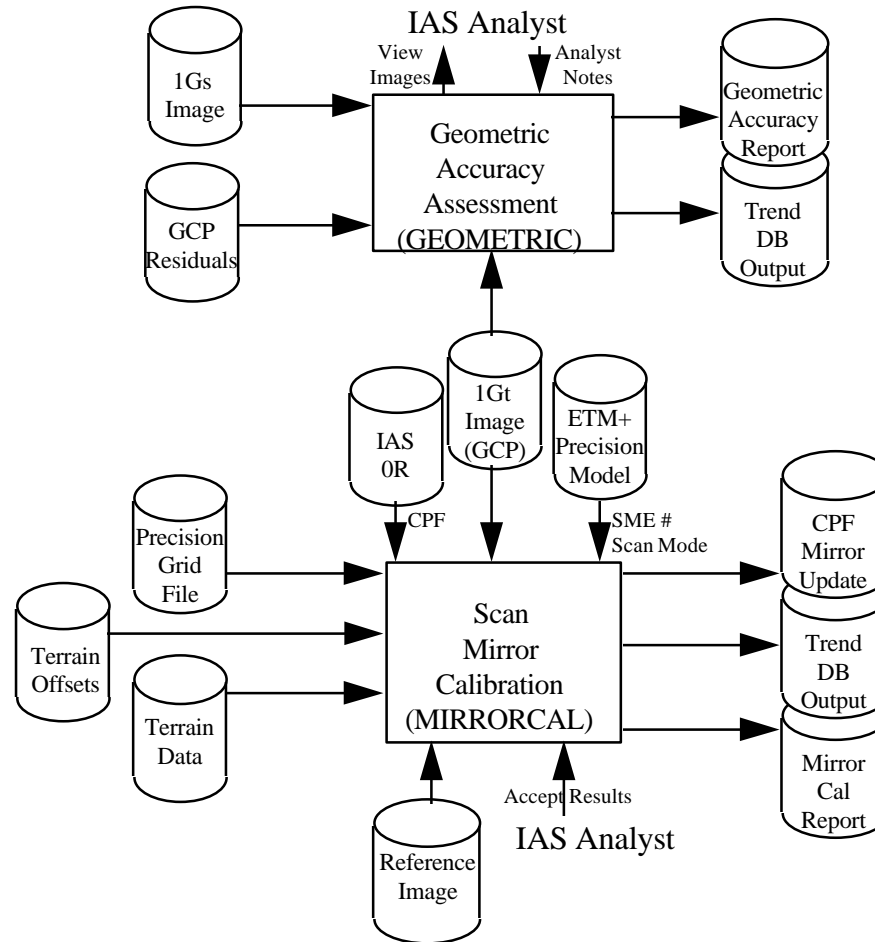


Geometric Super-Site Processing Phase 2



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Geometric Super-Site Analysis





Analyst Operations

- **Geodetic Test Site**
 - Geodetic Accuracy Assessment
 - Alignment Calibration
- **Geometric Super-Site**
 - Image-to-Image Registration
 - Geometric Accuracy Assessment
 - Scan Mirror Calibration
- **Band-to-Band Test Site**
 - Band-to-Band Registration Assessment
 - Band Placement Calibration
- **Analysis functions are accessed through custom IDL Graphical User Interfaces**
 - GUI interaction with software and analyst documented in STDs
 - Prototype GUI developed to demonstrate widget types

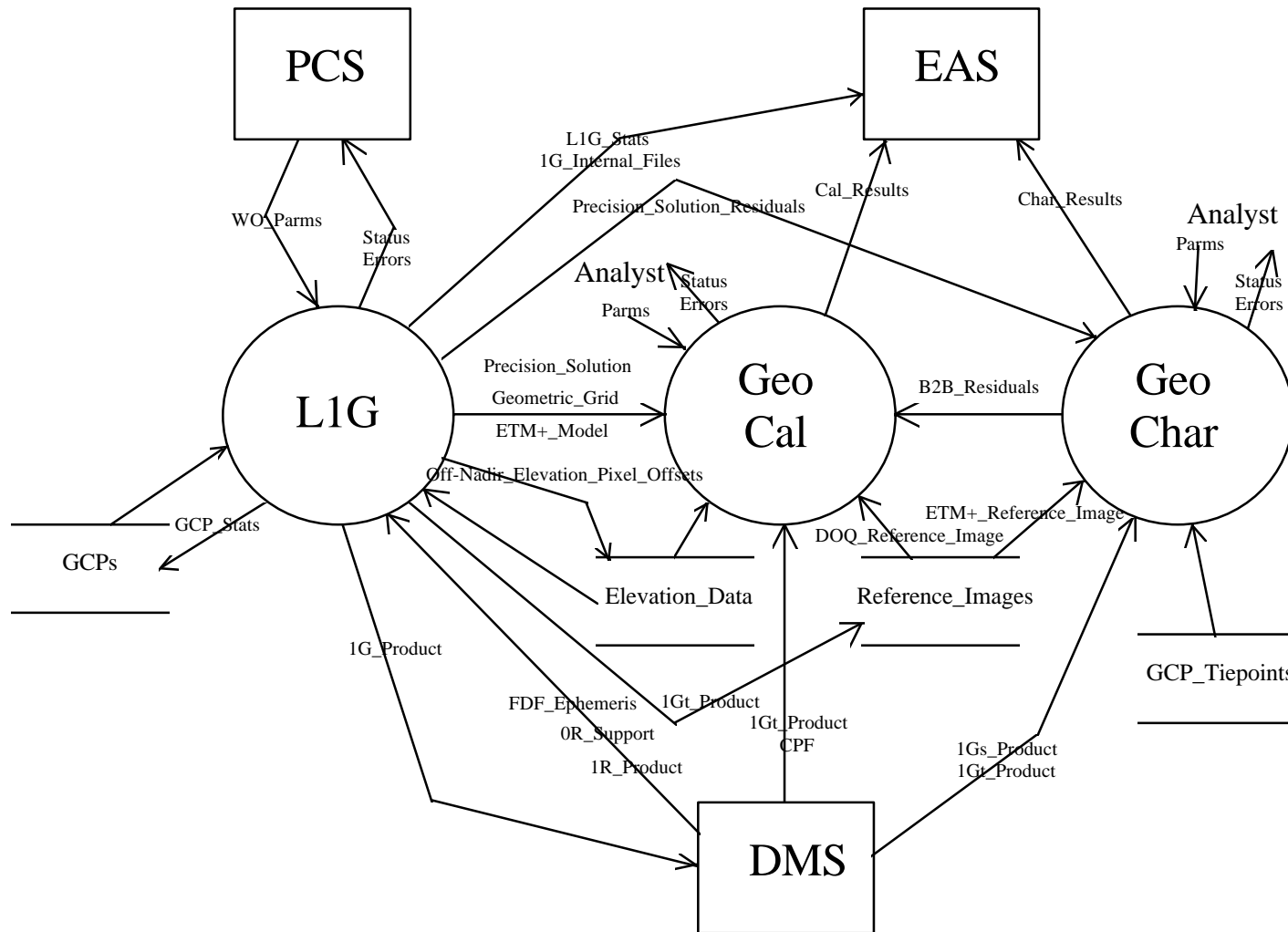


GPS Processes

- **Level 1G Processes**
 - TMINIT - model initialization
 - TMGRID - correction grid generation
 - TMRESAMPLE - image resampler
 - GCPCORRELATE - control point correlation
 - TMPRECISION - precision correction computation
 - GCPLIBSTATS - GCP library update
- **Geometric Characterization**
 - GEODETIC - geodetic accuracy assessment
 - GEOMETRIC - geometric accuracy assessment
 - B2BCHAR - band-to-band registration assessment
 - I2ICHAR - image-to-image registration assessment
- **Geometric Calibration**
 - ALIGNCAL - sensor alignment calibration
 - MIRRORCAL - scan mirror calibration
 - BANDCAL - band placement calibration



GPS Overview





L1G Processing Flow

- **Create and initialize L7/ETM+ model - TMINIT**
- **Generate systematic image correction grid from model - TMGRID**
- **Create systematic (1Gs) image - TMRESAMPLE**
- **Measure ground control in systematic image - GCPCORRELATE**
- **Compute updates to model to fit ground control - TMPRECISION**
- **Record ground control point performance - GCPLIBSTATS**
- **Generate precision image correction grid from updated model - TMGRID**
- **Generate precision (1Gp) or terrain corrected (1Gt) image - TMRESAMPLE**
- **Processes share a common set of support libraries**
- **Processes are invoked by scripts with associated default input parameters selected for use in a particular context**



Level 1G Processes - TMINIT

- **Key Functions**
 - Process PCD and MSCD to create the L7/ETM+ model
 - Option to use PCD ephemeris or FDF definitive ephemeris
 - Optionally verify L0R metadata scene center, scene corners, and sun angles
- **Inputs**
 - Time corrected PCD and MSCD from 0R product
 - CPF and metadata from 0R product
 - FDF definitive ephemeris file (optional)
 - Work order parameter file
- **Outputs**
 - ETM+ model file (ASCII)
 - Metadata report file (optional)
 - Attitude data processing trending output
- **Invoking Scripts**
 - TMINIT-PCD and TMINIT-DEFINITIVE



Level 1G Processes - TMGRID

- **Key Functions**
 - Define output image coordinate system (frame) using input parameters (e.g., corners, projection, pixel size, orientation)
 - Include options for minbox (MBR) and standard path-oriented frame computation
 - Create grid of points in input (1R) image space and compute corresponding output (1G) image space locations
- **Inputs**
 - ETM+ model file (systematic or precision)
 - CPF and DDR from L1R input
 - Work order parameter file
- **Outputs**
 - Grid file (HDF)
- **Invoking Scripts**
 - TMGRID-SYS and TMGRID-PREC



Level 1G Processes - TMRESAMPLE

- **Key Functions**
 - Generate 1Gs (1Gp) image by applying a systematic (precision) correction grid to the L1R input image
 - Generate a 1Gt image by incorporating corrections for terrain effects computed from a digital elevation model
 - Provide CC, NN, and MTFC interpolation options
- **Inputs**
 - L1R image, DDR, and CPF
 - Grid file (systematic or precision)
 - DEM (with DDR) and ETM+ model file (terrain correction only)
 - Work order parameter file
- **Outputs**
 - L1G image and DDR
 - Terrain correction table (terrain correction only)
 - Scan gap trending output
- **Invoking Scripts**
 - TMRESAMPLE-SYS, TMRESAMPLE-PREC, TMRESAMPLE-TERR



Level 1G Processes - GCPCORRELATE

- **Key Functions**
 - Extract GCPs from library based on input criteria (e.g., date, source)
 - Compute predicted GCP locations in 1Gs image and extract windows
 - Correlate GCP chips with windows to measure actual location
 - Update correlation statistics in GCP library
- **Inputs**
 - GCP library file
 - GCP image chips
 - 1G image and DDR
- **Outputs**
 - GCP data file (correlated locations)
 - GCP library file statistics update
- **Invoking Scripts**
 - TMPRECISION-AUTO and TMPRECISION-GCP



Level 1G Processes - TMPRECISION

- **Key Functions**
 - Use GCP measurements to compute corrections to ephemeris and attitude in ETM+ model file
 - Can be executed in automated or interactive modes to allow the analyst to evaluate and adjust the results of automatic outlier detection and rejection
- **Inputs**
 - GCP data file
 - ETM+ model file (systematic)
 - Grid file
 - L1R and L1Gs DDR files
 - Work order parameter file
- **Outputs**
 - Precision solution and GCP residual files (ASCII)
 - Precision ETM+ model file
- **Invoking Scripts**
 - TMPRECISION-AUTO and TMPRECISION-ANALYST



GPS Libraries

- **ETM+ Model Library**
 - Model support (e.g., attitude processing, LOS projection)
- **Geometric Library**
 - Geometric support (e.g., Map projections, coord transforms)
- **Algorithm Library**
 - Geometry algorithm support (e.g., correlation)
- **Math Library**
 - Basic math (e.g., matrix algebra, statistics)
- **Utility Library**
 - GPS data handling (e.g., GCP library manipulation)
- **File I/O Libraries**
 - GPS specific files (e.g., Grid, DDR, Terrain data)
- **Global Libraries**
 - CPF, PCD, MSCD, image I/O
 - Process status and error handling
 - Database I/O (trending)



Geometric Char Processes - GEODETIC

- **Key Functions**
 - Analyze output of GCP mensuration in 1Gs image (pre-fit) to assess systematic geodetic accuracy
 - Report results to trending database
 - C application invoked by IDL user interface
- **Inputs**
 - Precision correction residual file
- **Outputs**
 - Report file (ASCII)
 - Trending data (DB)
- **Associated Procedure**
 - Geodetic Accuracy



Geometric Char Processes - GEOMETRIC

- **Key Functions**
 - Analyze output of precision correction to assess internal geometric accuracy
 - Report results to trending database
 - C application (invoked by IDL user interface) analyzes post-fit residuals to detect remaining distortion
 - IDL tools used to display image and analysis results
- **Inputs**
 - Precision correction residual file
 - 1Gs or 1Gt image
- **Outputs**
 - Geometric accuracy report file (ASCII)
 - Trending data (DB)
- **Associated Procedure**
 - Geometric Super-Site



Geometric Char Processes - IMAGE TO IMAGE

- **Key Functions**
 - Correlate 1Gt image with reference scene to measure multi-temporal image-to-image registration
 - Test points may be pre-defined or automatically generated
 - Report results to trending database
 - C applications invoked by IDL user interface
- **Inputs**
 - 1Gt image and DDR
 - Reference 1Gt image and DDR
 - Tie point location file (optional)
- **Outputs**
 - Correlation results file (ASCII)
 - Report file (ASCII)
 - Trending data (DB)
- **Associated Procedure**
 - Image Registration



Geometric Char Processes - BAND TO BAND

- **Key Functions**
 - Correlate across 1Gs image bands to measure band-to-band registration
 - Test points may be pre-defined or automatically generated
 - Report results to trending database
 - C applications invoked by IDL user interface
- **Inputs**
 - 1Gs image and DDR
 - Tie point location file (optional)
- **Outputs**
 - Correlation results file (ASCII)
 - Report file (ASCII)
 - Trending data (DB)
- **Associated Procedure**
 - Band to Band



Geometric Cal Processes - ALIGNCAL

- **Key Functions**
 - Use Kalman filter to integrate new precision correction results into current best estimate of ETM+ to L7 alignment bias state
 - Report results to trending database
 - At analyst direction, construct new CPF alignment matrix
 - C applications invoked by IDL user interface
- **Inputs**
 - Precision solution file
 - CPF (from L1R product)
 - Alignment state file (ASCII)
- **Outputs**
 - Updated alignment state file
 - Report file (ASCII)
 - Trending data (DB)
 - CPF alignment matrix (ODL file)
- **Associated Procedure**
 - Sensor Alignment



Geometric Cal Processes - MIRRORCAL

- **Key Functions**
 - Correlate 1Gt image with non-ETM+ reference image to detect systematic deviations from scan mirror profile
 - Report results to trending database
 - At analyst direction, construct new CPF mirror profiles
 - C applications invoked by IDL user interface
- **Inputs**
 - 1Gt image (pan band) and DDR
 - Reference image and DDR
 - ETM+ model and grid files (precision)
 - DEM (with DDR) and terrain correction table
 - CPF from input L1R product
- **Outputs**
 - Report file (ASCII) and trending data (DB)
 - CPF mirror profiles (ODL file)
- **Associated Procedure**
 - Geometric Super-Site



Geometric Cal Processes - BANDCAL

- **Key Functions**
 - Compute best fit band center location updates using results of band-to-band registration assessment
 - Report results to trending database
 - At analyst direction, construct new CPF band center locations
 - C applications invoked by IDL user interface
- **Inputs**
 - Band-to-band correlation results file
 - Grid file
 - L1R DDR and CPF
- **Outputs**
 - Report file (ASCII)
 - Trending data (DB)
 - CPF band center locations (ODL file)
- **Associated Procedure**
 - Band to Band

IAS Critical Design Review



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Interactive Interface

D. Kaufmann/M. Schienle

**Management &
Control**

L1 Processing

**Evaluation &
Analysis**

Database



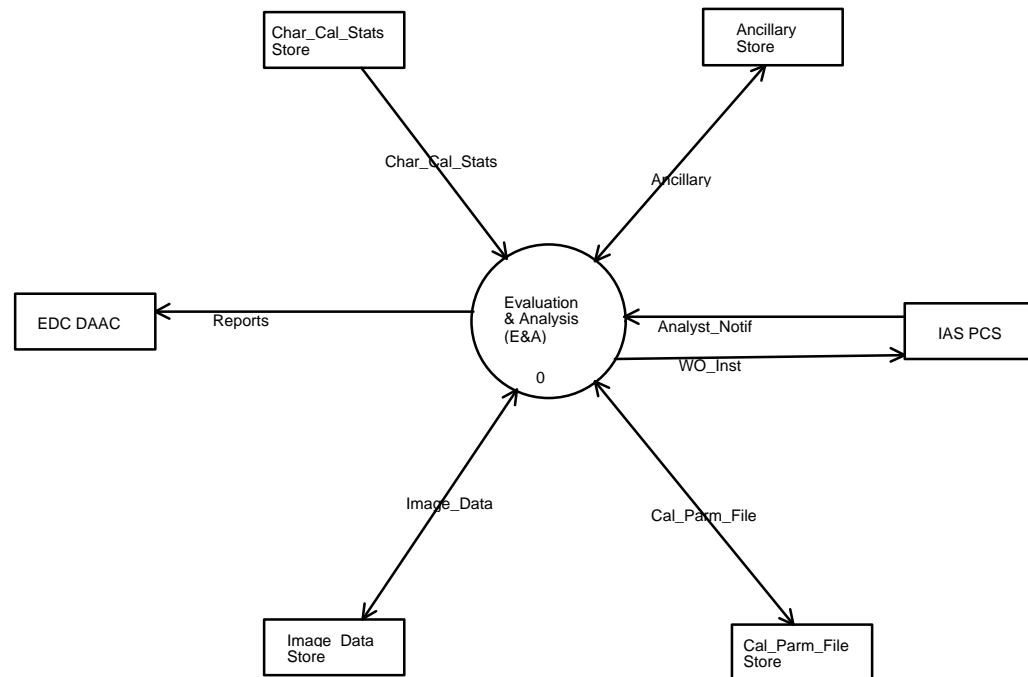
Evaluation and Analysis Subsystem Purpose

- **The purpose of the E&A Subsystem is to provide the tools required by an IAS analyst to**
 - **evaluate and analyze ETM+ instrument performance**
 - **maintain the Calibration Parameter File**
 - **perform anomaly investigations**
 - **generate reports detailing calibration, assessment, evaluation, and anomaly resolution activities**

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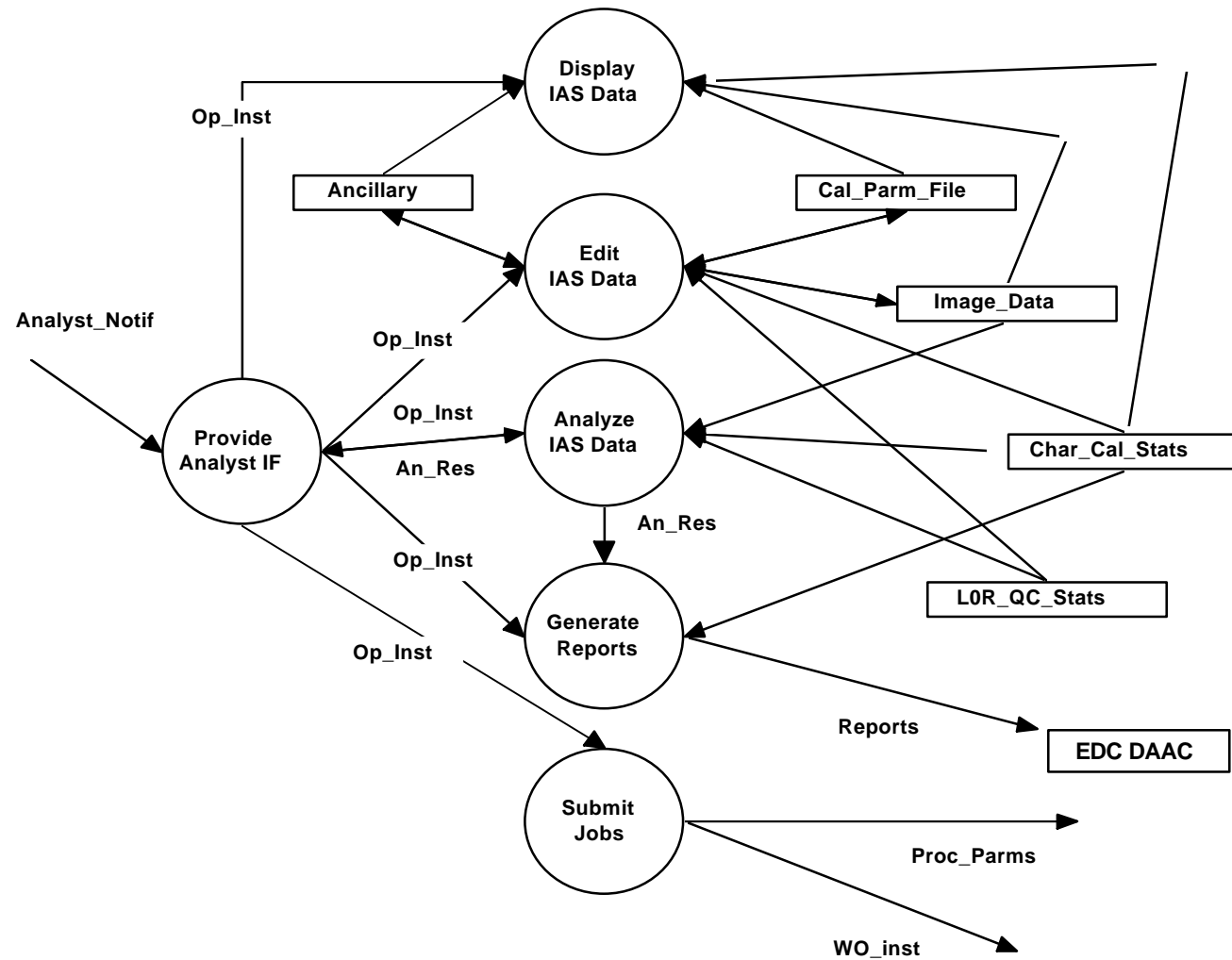
E&A Context Diagram



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Primary E&A Functions



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E&A COTS Products (1 of 3)



- **Interactive Data Language (IDL)**
 - designed for general-purpose data analysis and visualization, and application development
 - satisfies E&A requirements for data analysis and plotting functionality
 - provides the capability to produce “canned” routines for standard trending plots
 - enables development of fill-in forms for editing work order input files for “what if” analyses
 - text widget enables viewing of output ASCII files



- **Environment for Visualizing Images (ENVI)**
 - designed for panchromatic, multispectral, and hyperspectral analysis of satellite and aircraft remotely-sensed data
 - provides a customizable graphical user interface (GUI) for the E&A subsystem
 - satisfies E&A requirements regarding image visualization, editing, analysis and output
 - GUI provides access to custom radiometric and geometric applications as well as to other COTS tools
 - implemented in IDL

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E&A COTS Products (3 of 3)

- **FrameMaker**
 - document publishing software package that includes page layout, word processing, graphics, equations, and tables
 - used to generate IAS reports
- **Oracle**
 - Oracle forms used by the IAS analyst for work order submissions and database queries
 - provides access to trending data for analysis



- **Retrieve Data from the Oracle Database into IDL**
 - facilitates trending analysis as well as custom IAS applications requiring database access
- **View L0R Ingest Reports**
 - provides formatted display of L0R ingest reports
- **Perform Impulse Noise Analysis**
 - provides the capability to perform bit flip classifications in support of the evaluation of impulse noise
- **Perform Coherent Noise (CN) Analysis**
 - provides the capability to obtain, using the results of the CN algorithm, estimates of the random noise variance for comparison with the histogram analysis



- **Perform Random Noise Analysis**
 - provides the capability to convert and plot detector level means and standard deviations, as well as to view output plots and reports from the random noise characterization
- **Perform Gain Fitting for the CRaM**
 - provides the capability to perform gain fitting on the results of the CRaM algorithm, as well as to examine correlation coefficients between gain functions and analyze calibrator output degradation factors
- **Perform Evaluation of the Correct Coherent Noise Algorithm**
 - provides the capability to assess residual coherent noise components remaining in an image after coherent noise correction.
- **Perform Trending Analysis**
 - provides the capability to perform analysis on the data contained in the trending database

IAS Critical Design Review



Operator and Analyst User Interfaces

Operator Functions

- start system
- shutdown system
- set up system parameters
- archive to tape
- create new procedure

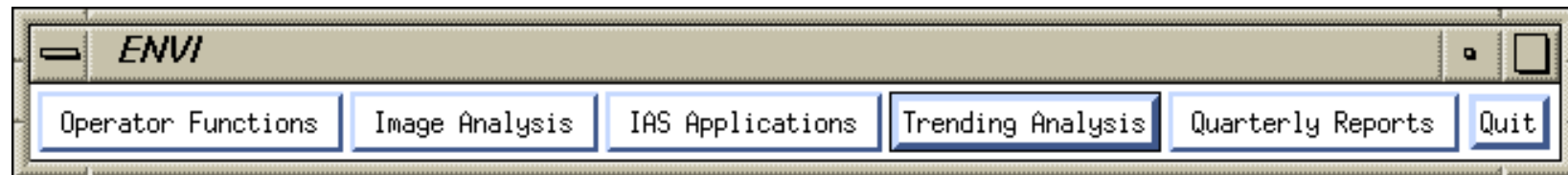
Analyst Functions

- set up, control, and monitor work orders
- generate Calibration Parameter File
- request data
- view catalogs
- view system activity
- perform image analysis
- execute custom IAS applications
- analyze trending data
- generate reports

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Analyst User Interface Main Menu

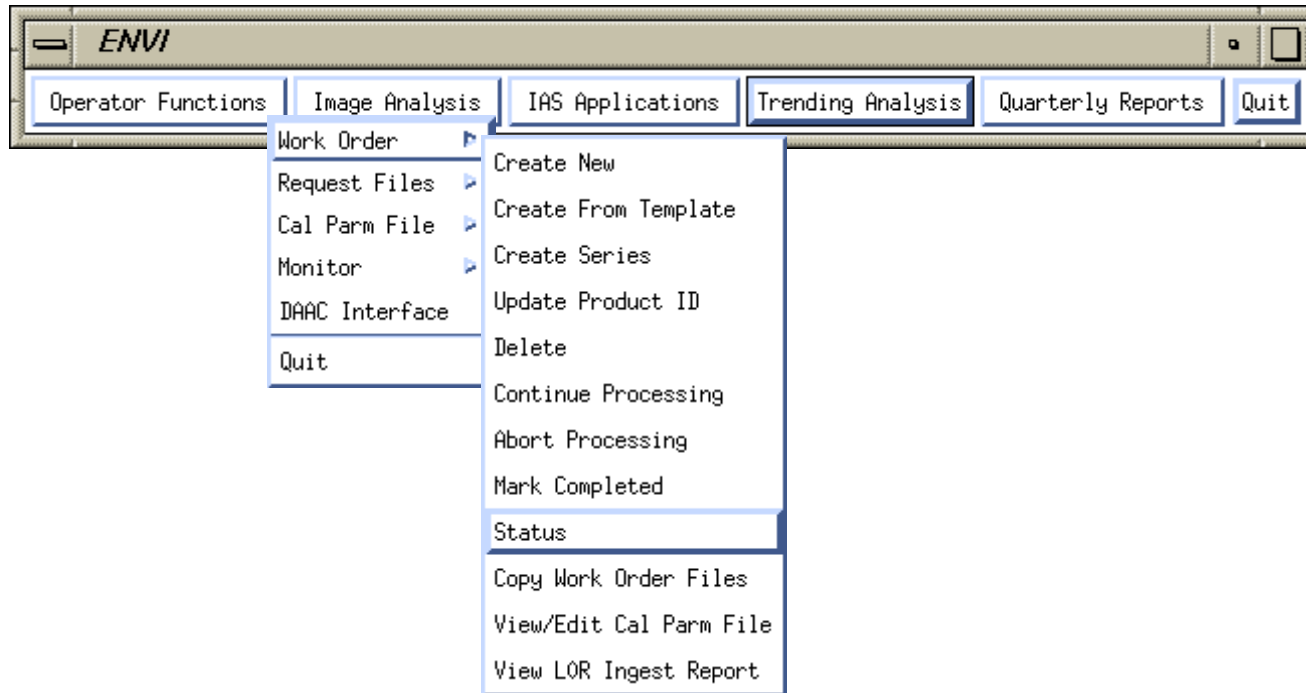


- Operator Functions
- Image Analysis
- IAS Applications
- Trending Analysis
- Quarterly Reports

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Obtaining Work Order Status (1 of 3)



- choose the “Status” selection from the Operator Functions/Work Order submenu

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Obtaining Work Order Status (2 of 3)

Work Order Status

System Work Order Request Files Cal Parm File Monitor

WORK ORDERS STATUS

Refresh Rate: Seconds

Work Order Id	LOR Product Id	Procedure Id	Script Id	State

Work Order Path:

LOR Path:

Count: *0

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Obtaining Work Order Status (3 of 3)

Work Order Status

System Work Order Request Files Cal Parm File Monitor

WORK ORDER SCRIPT STATUS

Work Order Id:

Type:

Work Order State:

Procedure Id:

Script Id	State	Exit Code
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

Parm Name	Array Element	Parm Value
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<input type="text"/>	<input type="text"/>	<input type="text"/>
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<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

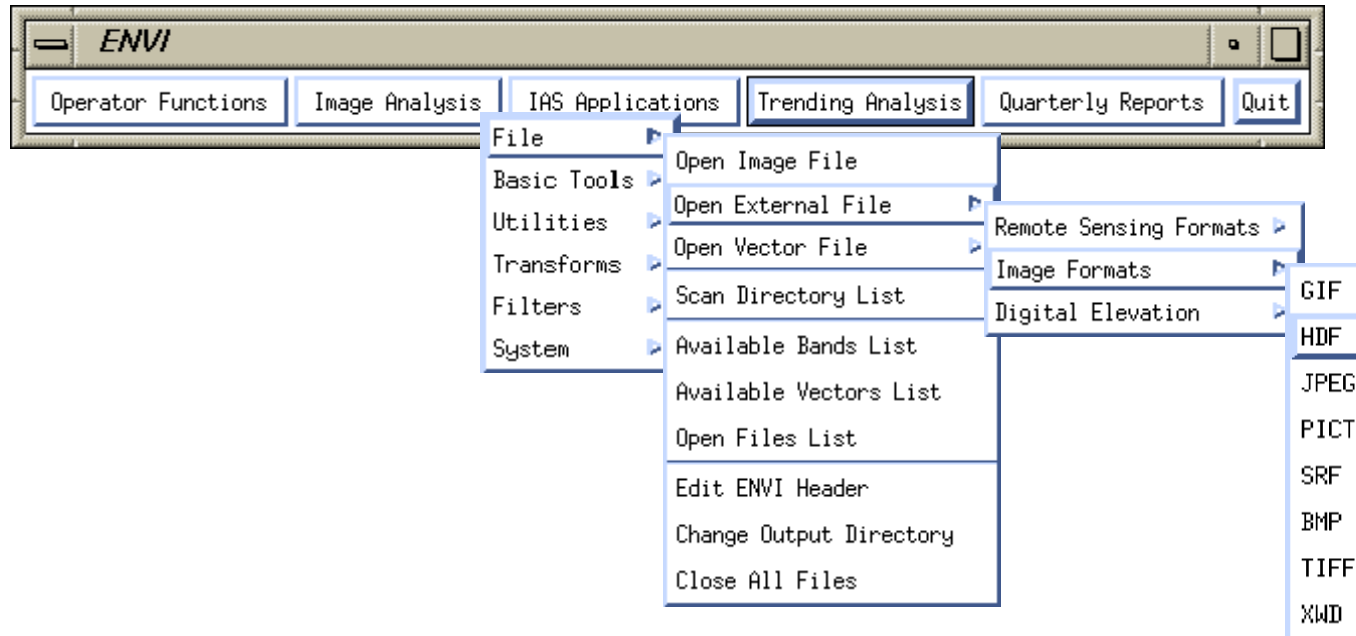
OK CANCEL

Count: *0 <Insert>

IAS Critical Design Review



Opening an Image File (1 of 3)

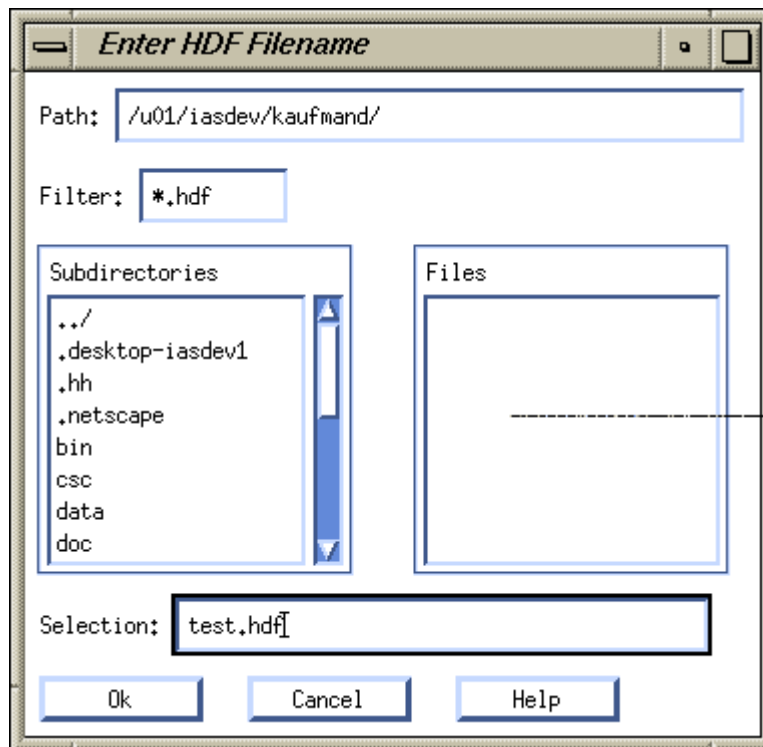


- choose the “HDF” selection from the Image Analysis/File/Open External File/Image Formats submenu

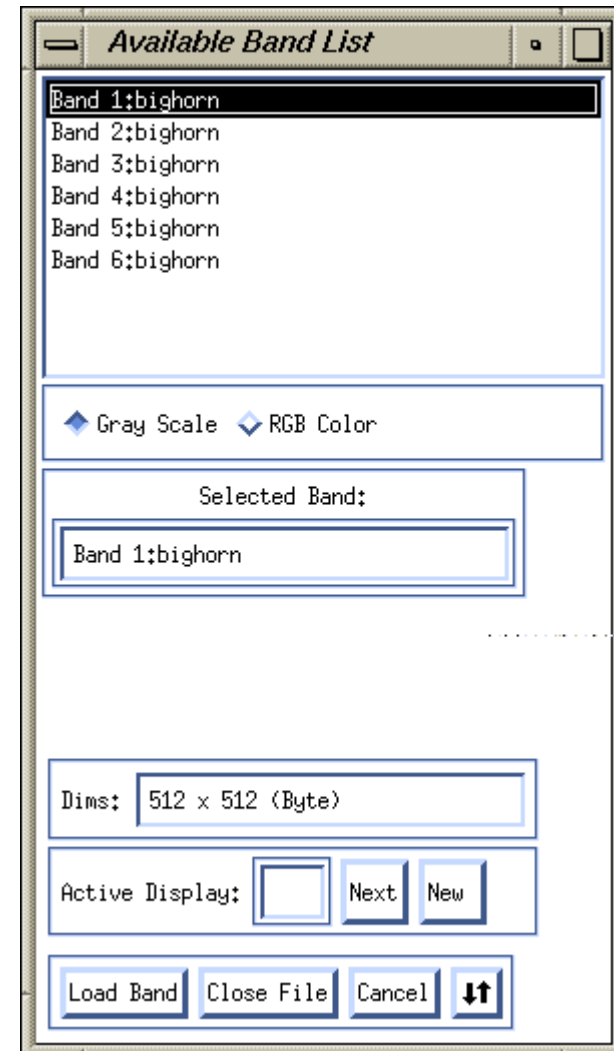


Opening an Image File (2 of 3)

HDF file selection window



Available band list

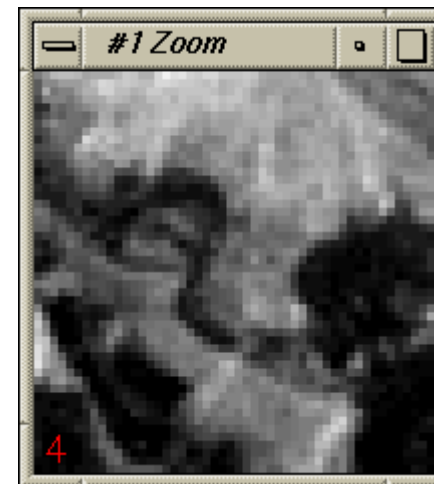
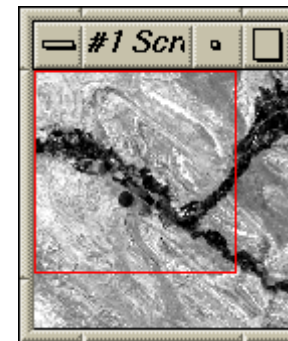
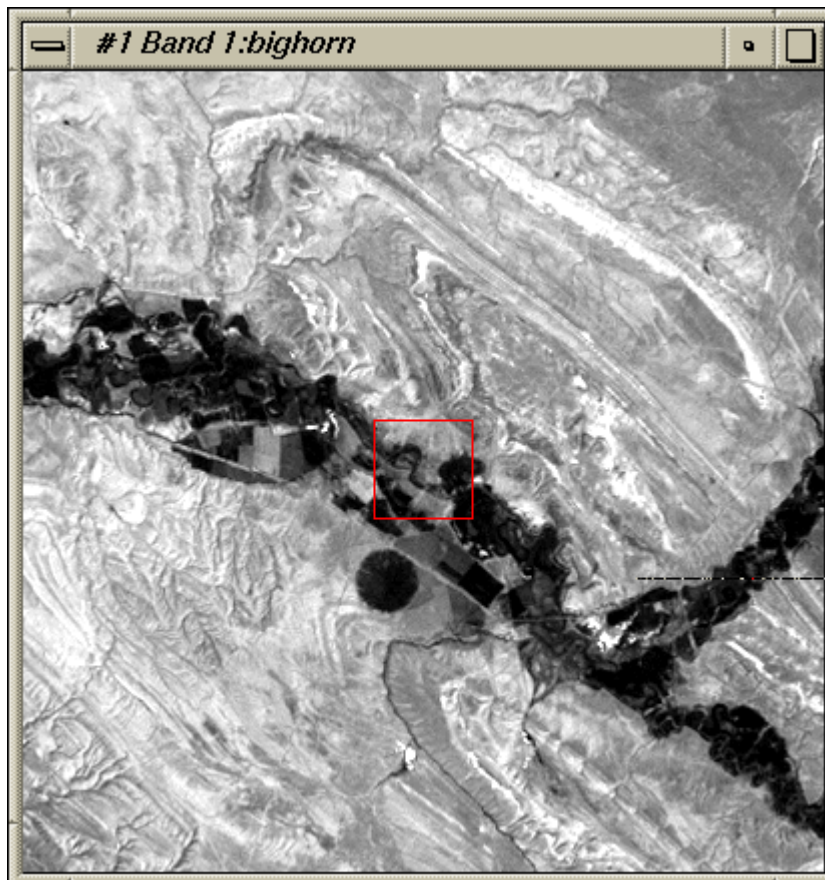


IAS Critical Design Review

Opening an Image File (3 of 3)

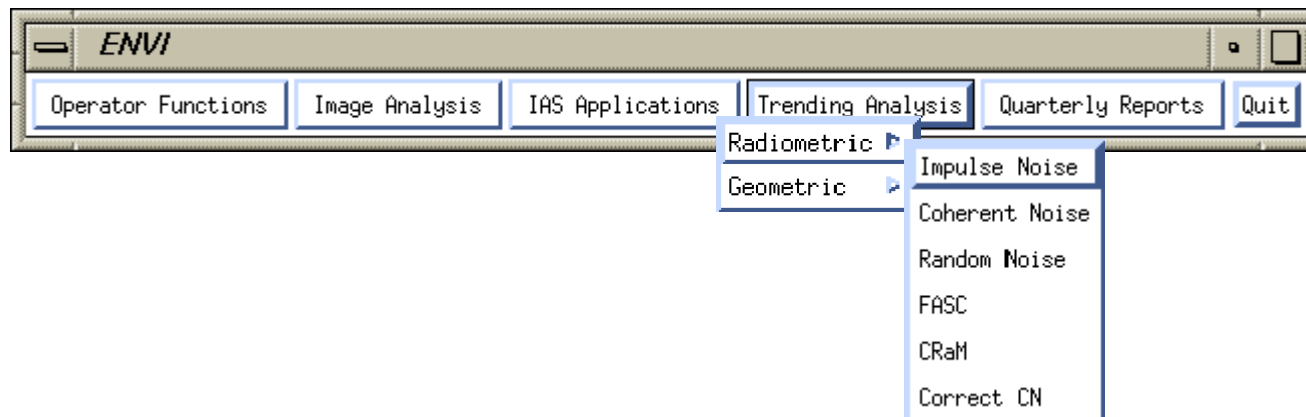


ENVI image display windows





Impulse Noise Example



- choose the “Impulse Noise” selection from the IAS Applications/Radiometric submenu



Database query

Impulse Noise - Query

Impulse Noise Query

WRS Path: WRS Row: -

Start Time: End Time:

Data Type:

Trend Data Source:

Band: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7

Detectors: (ALL or comma delimited list)

Bit Flip Classification

Impulse Noise - Bit Flip Characterization

Impulse Noise Occurrences

Data Type: FASC Row/Paths: 123/023-028 Bands: 1-5 Detectors: ALL

B	Det	Scan	mf	-1	CV	+1	MSB Flips
1	9	411	286	12	154	31	YNNN
1	9	421	375	13	176	27	YNNY
1	9	431	464	12	159	19	NNYN
1	9	441	553	11	142	20	NYYN
1	9	501	123	11	163	43	####
1	9	511	286	12	154	31	####
1	9	521	375	13	176	27	####
1	9	531	464	12	159	19	####
2	3	541	553	11	142	20	####
2	3	601	123	11	163	43	####
2	3	611	286	12	154	31	####
2	3	621	375	13	176	27	####



Band Registration Characterization Prototype

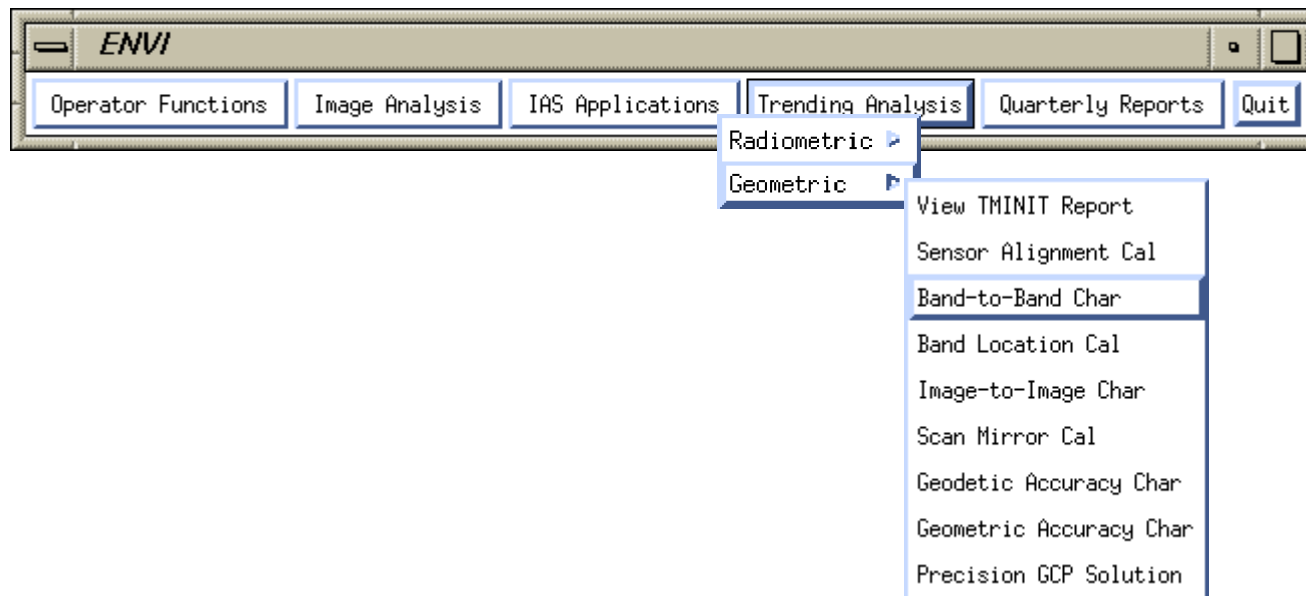
- **Prototype IDL GUI developed to demonstrate IAS geometric analyst user interface concepts**
- **Band-to-band registration characterization selected for prototype**
 - **Most complex data display and management requirements**
 - **Includes tabular data display (test points and residuals) and plotting (vector, contour, surface) requirements common to most other geometric characterization processes**
- **IDL user interface procedure invokes custom C software to perform IAS-specific processing (test point generation and correlation)**
- **Built-in IDL functions used for statistical analysis, display, and plotting**
- **Invoked interactively from E&A environment via Analyst Menu**

IAS Critical Design Review

IAS Applications (Geometry)



Band-to-Band Characterization Example



- choose the “Band-to-Band Char” selection from the IAS Applications/Geometric submenu

IAS Critical Design Review



Band Registration Parameter Entry Screen

Band to Band Registration

Work Order: Dir /usr/people/schi

Reference Band: Band #1 Band #5

Band #2 Band #6

Band #3 Band #7

Band #4

Files: MTP Filename All

Image Filename

Output: /usr/people/schi

Search Band: Band #1 Band #5

Band #2 Band #6

Band #3 Band #7

Band #4 Band #8

Correlation: Threshold: 0.0000

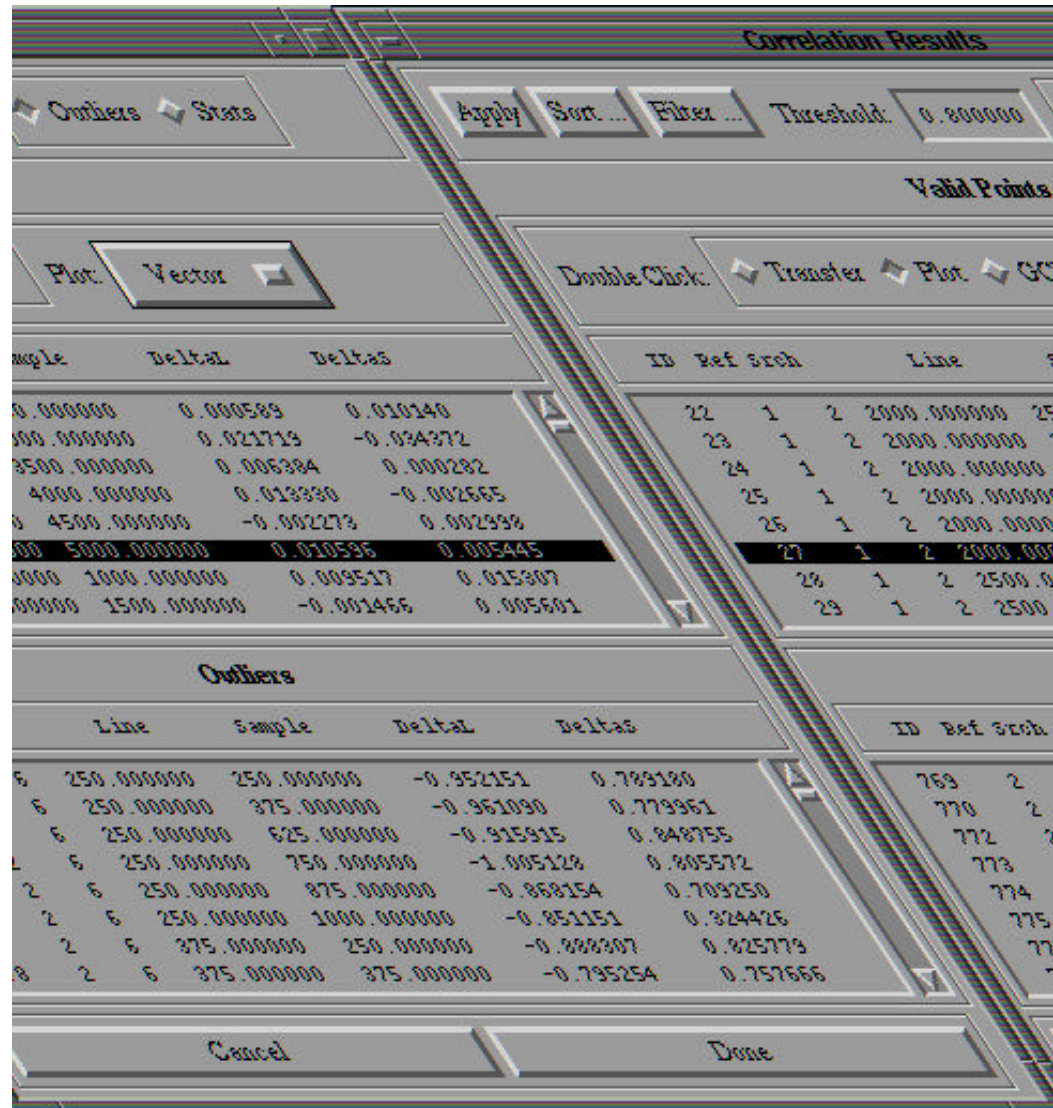
output: Trend DB

Close Correlate Write Output

IAS Critical Design Review



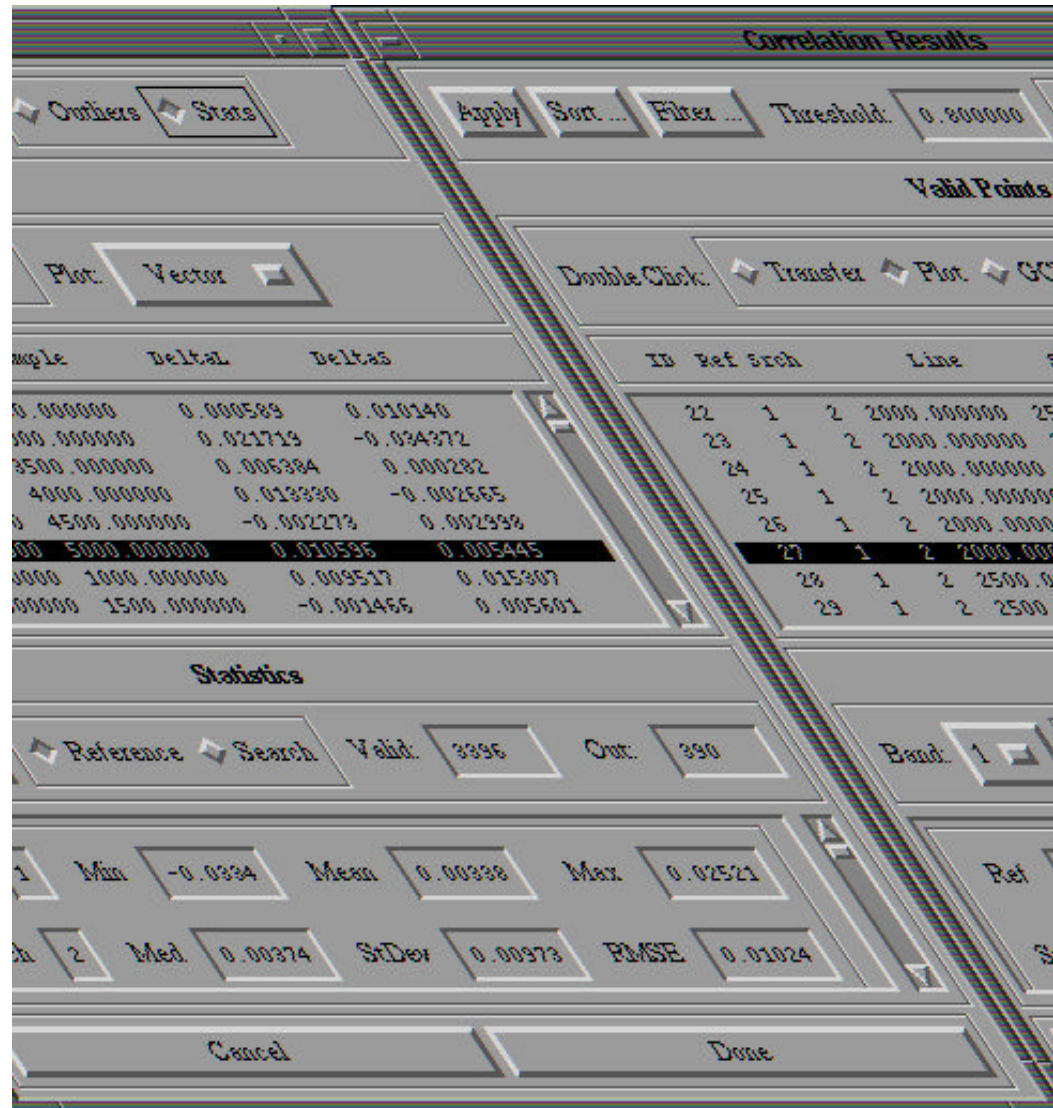
Correlation Results - Valid Points and Outliers



IAS Critical Design Review



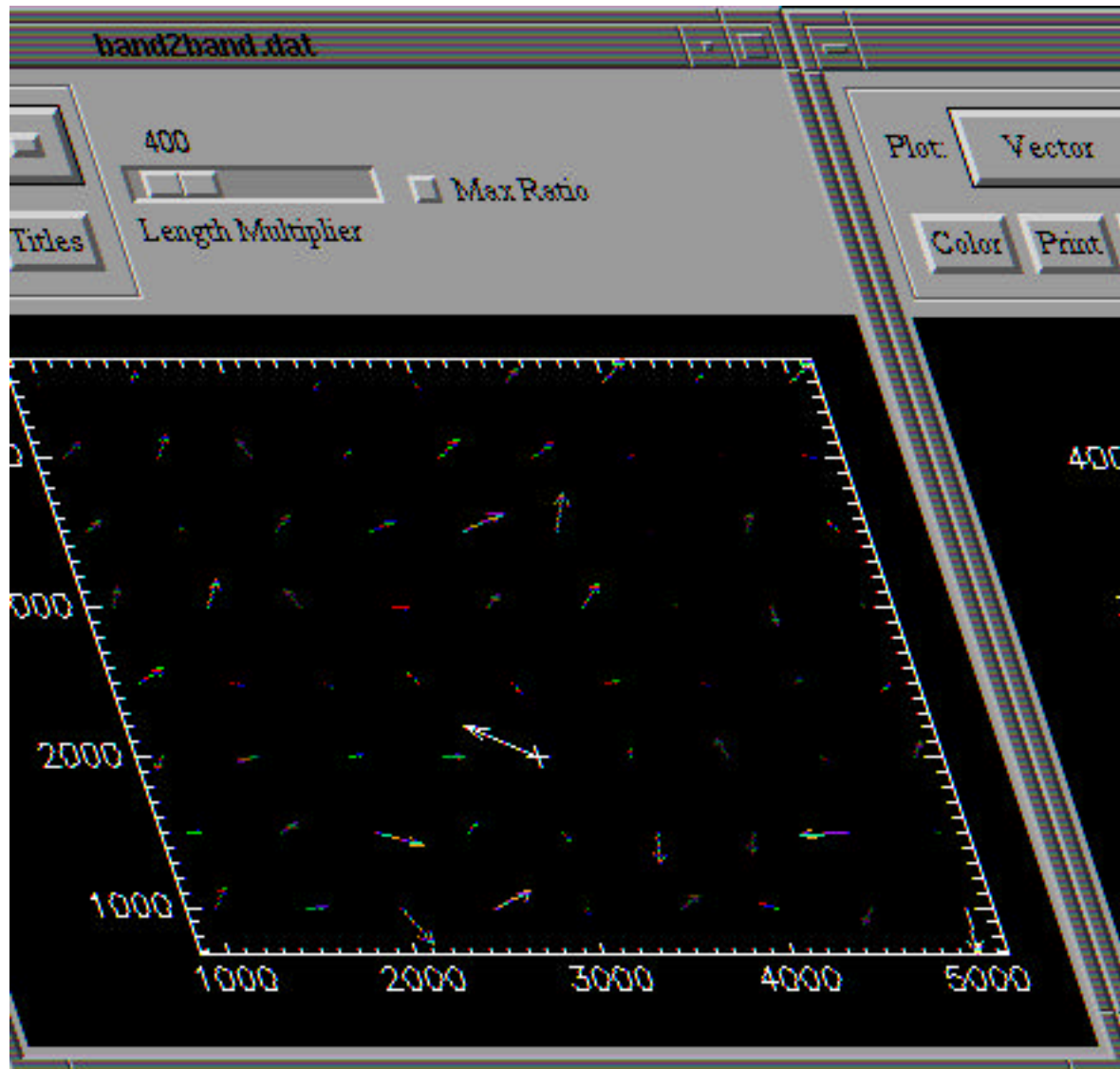
Correlation Results - Valid Points and Statistics



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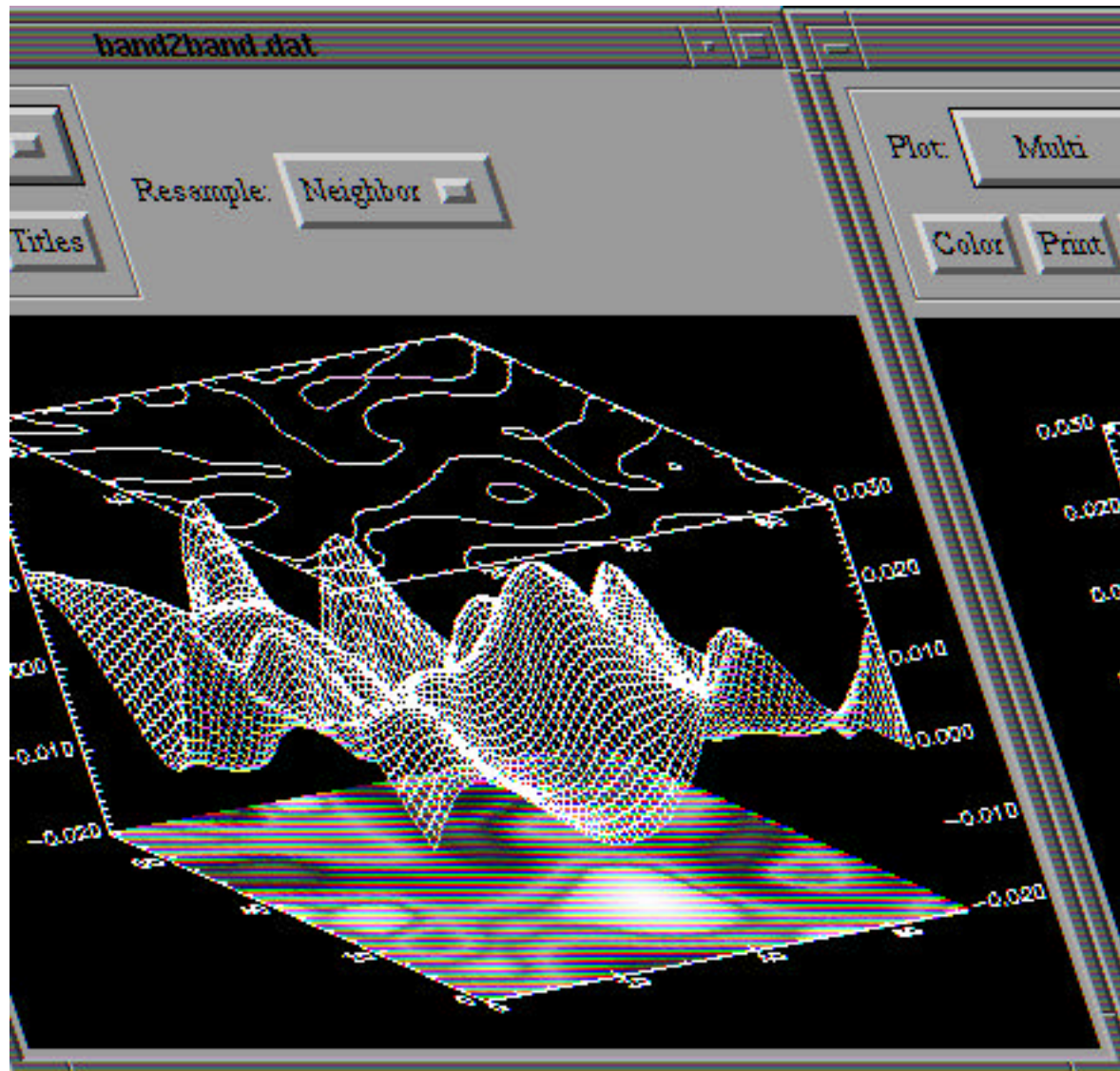
Band Registration Vector Plot Screen



IAS Critical Design Review



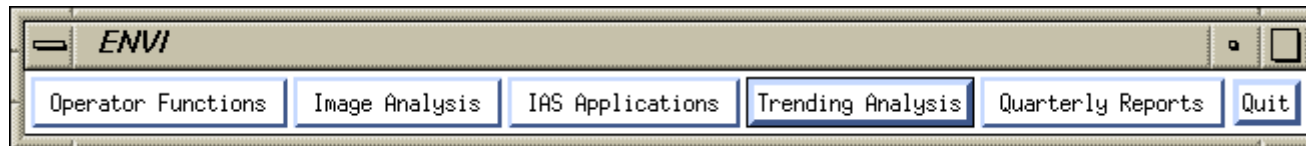
Band Registration 3D Plot Screen



IAS Critical Design Review



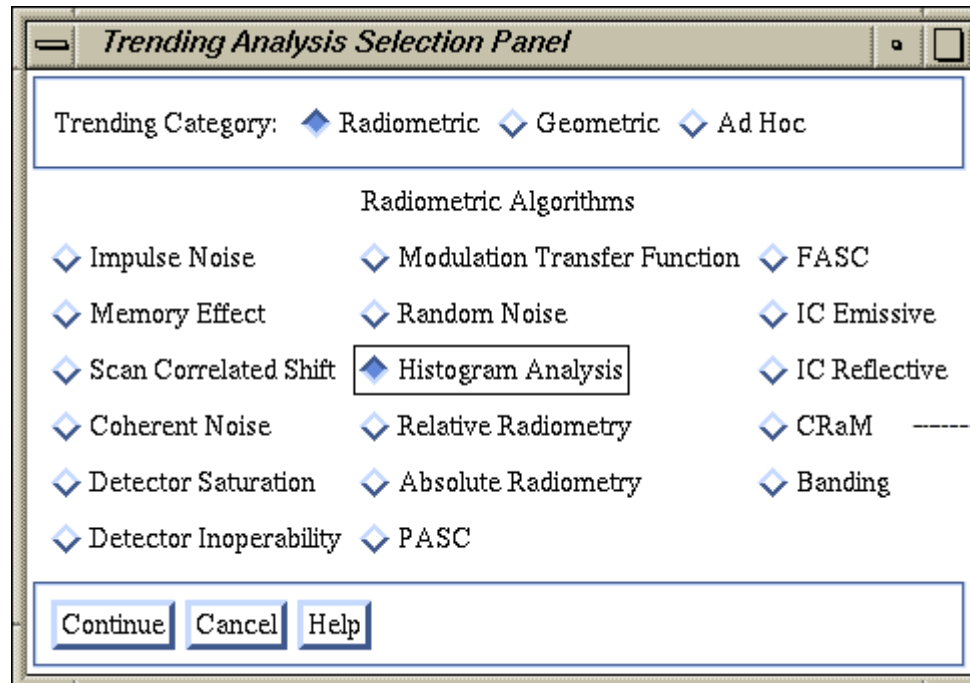
Trending Analysis (1 of 5)



- choose the “Trending Analysis” selection from the Analyst User Interface main menu



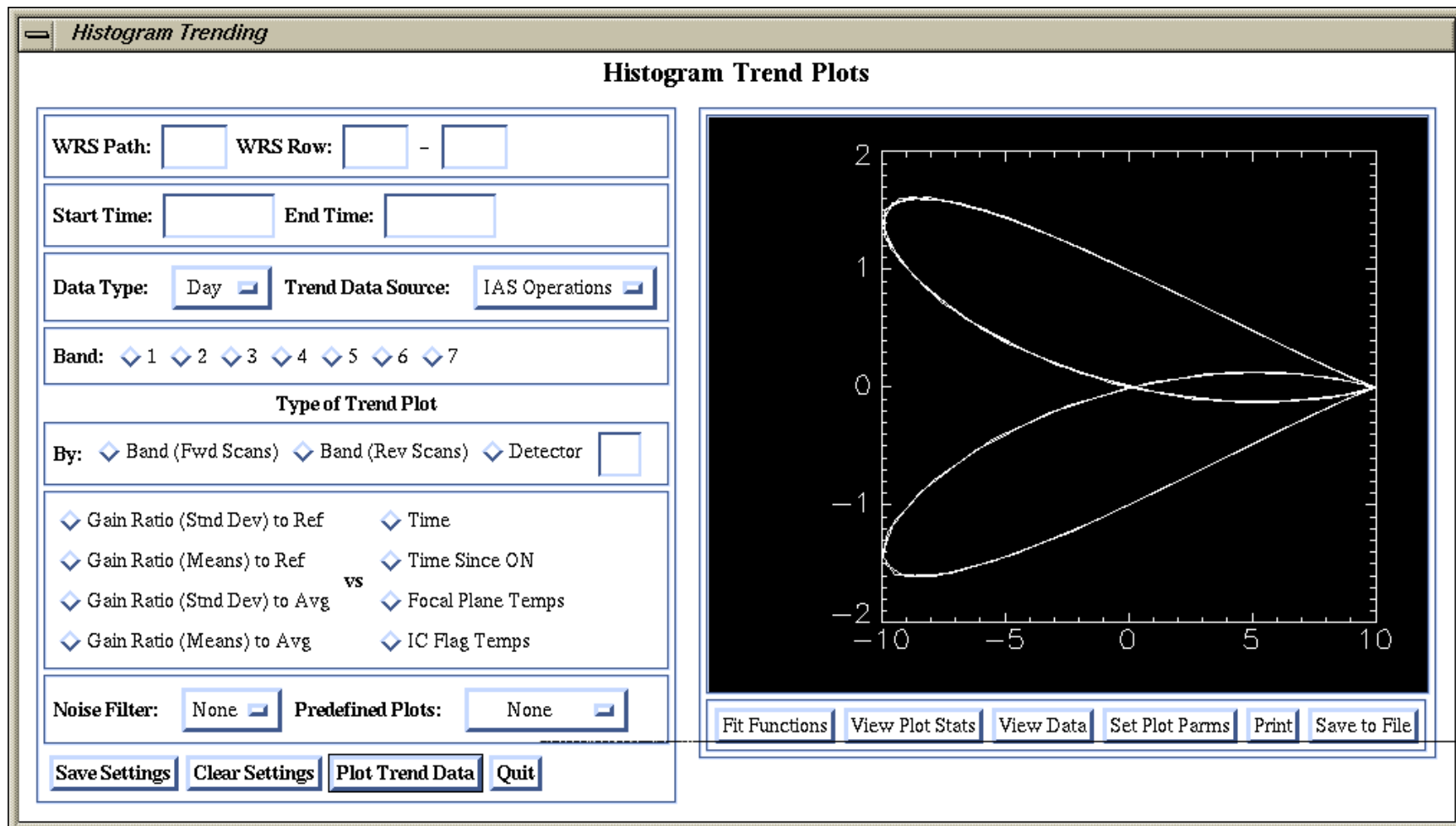
Trending selection





Trending Analysis (3 of 5)

Histogram trending window





Function fitting

Function Fitting Window

Available Functional Forms

Linear: $y = A + Bx$

Quadratic: $y = A + Bx + Cx^2$

Cubic: $y = A + Bx + Cx^2 + Dx^3$

Exponential: $y = A + B \exp(Cx)$

Fitted Parameter Values

A = no value B = no value

C = no value D = no value

Perform Fit Plot New Overplot Done

Viewing data

View Data

X	Y
2	5
7	8
8	6
99	33
9	9
0.2	22
1	22
0.44	1.222
9	8
7	9
1.2	99
8	8
0.1	9
0	1
9.9	1.2
1.2	0.1
9.1	1
4	1
8.4	8.8
9.9	8

DONE



Setting plot parameters

Set Plot Parameters

Available Plot Symbol Types

☐ plus sign (+) ☐ period (.) ☒ triangle ☐ cross (X)

☐ asterisk (*) ☐ diamond ☐ square ☐ histogram mode

X-Axis Controls

☒ Linear ☐ Logarithmic

XMIN

XMAX

Y-Axis Controls

☒ Linear ☐ Logarithmic

YMIN

YMAX

Viewing plot statistics

Plot Statistics

Minimum:

Maximum:

Mean:

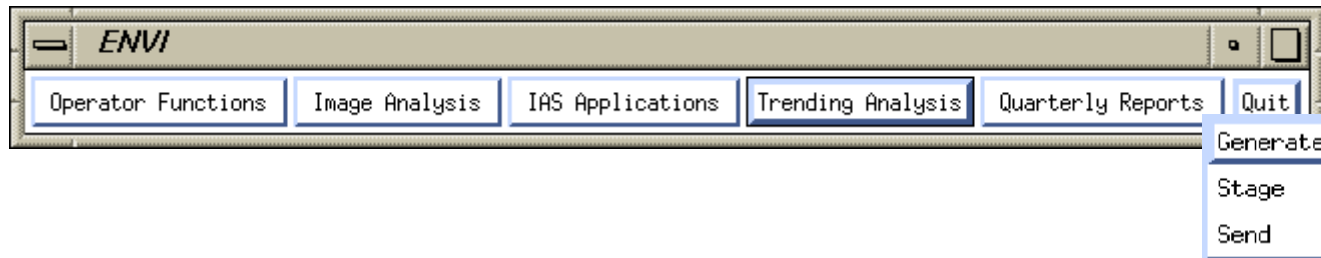
Median:

Variance:

Std Dev:

IAS Critical Design Review

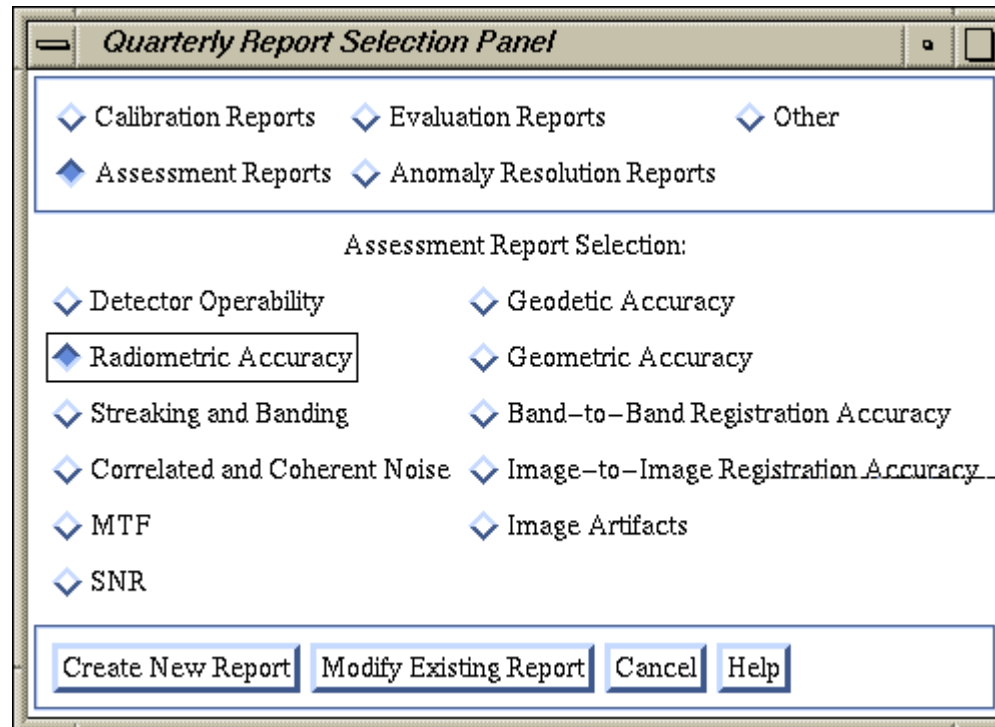
Report Generation (1 of 2)



- choose the “Generate” selection from the Quarterly Reports menu



Selecting the report



- selection launches FrameMaker with the appropriate report template or existing report

IAS Critical Design Review



Agenda

- | | |
|---------------------------|-------------------------|
| • Introduction | R. Schweiss |
| • Design Overview | S. Johnston |
| • Hardware Architecture | C. Brambora |
| • Operational Scenarios | S. Johnston |
| • Software Design | |
| – Overview | J. Hosler |
| – Operations Interface | J. Whelan |
| – Management and Control | A. Williard |
| – Database | A. Williard |
| – L1 Processing | T. Ulrich |
| | J. Storey |
| – Evaluation and Analysis | D. Kaufmann/M. Schienle |
| • System Test | E. Crook |
| • Conclusion | R. Schweiss |

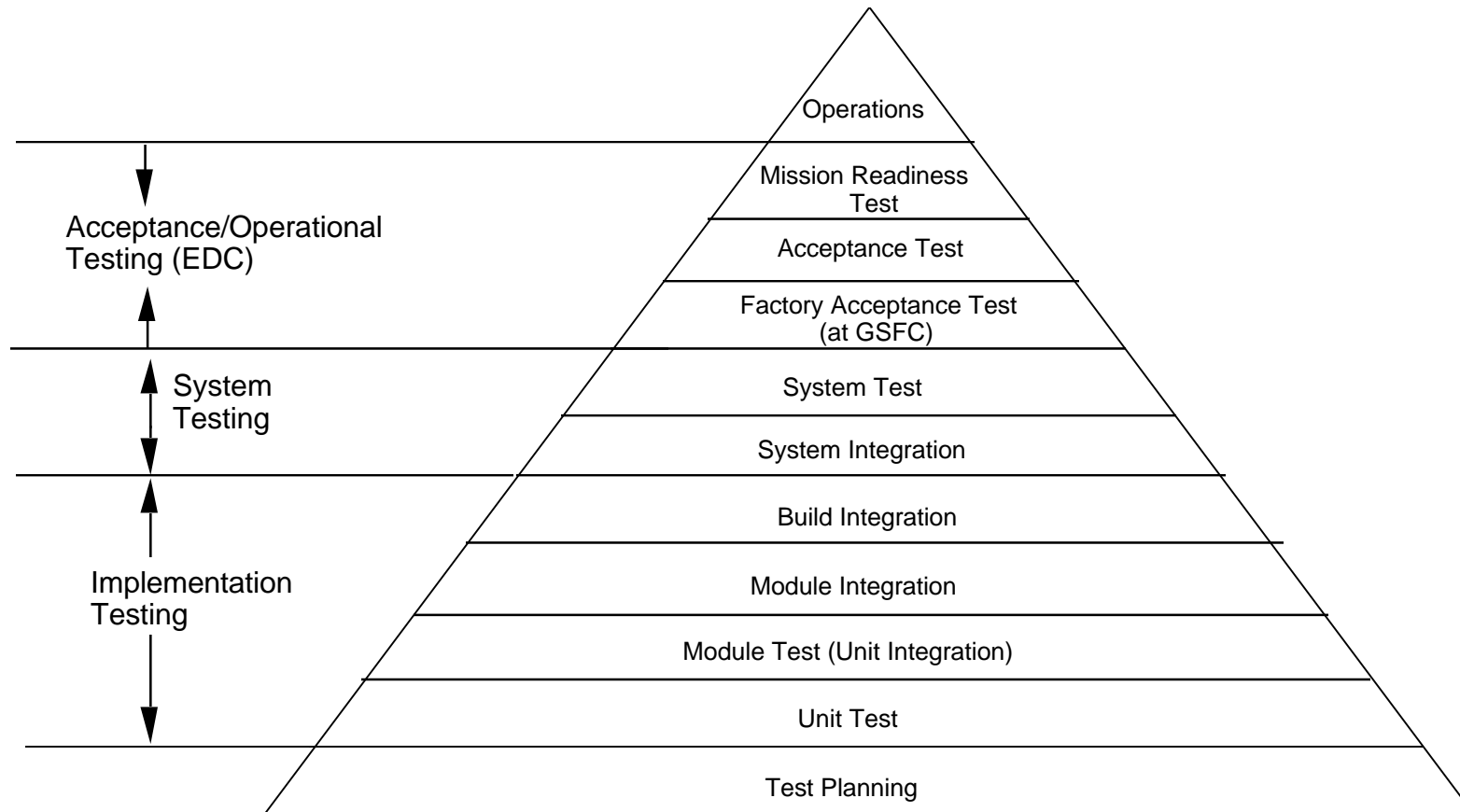


Agenda

- **System Test**
 - **System Test Objective**
 - **System Test Strategy**
 - **Algorithms testing and verification**
 - **System Test Processes**
 - **Configuration Control Activities**
 - **System Test Activities**
 - **System Test Tools**
 - **System Test Issues**

IAS Critical Design Review

System Test Objective



IAS Critical Design Review

System Test Strategy



- **Conduct rigorous algorithm testing during the module test phase**
- **Once in the system test phase, compare algorithm results**
- **Verify proper implementation of interfaces**
- **Verify compliance with requirements**

IAS Critical Design Review

Algorithm Testing & Verification



Radiometry Algorithm Testing

- **Joint testing effort (testing & development)**
- **Identify algorithm test cases**
- **Identify test tools requirements (Test data, drivers and stubs)**
- **Verify Test Tools**
- **Conduct tests**
- **Analyze and verify test results (developers, testers, consultants, science team ...)**

Geometry Algorithm Testing

- **EDC testing effort**
- **Conduct tests and verify test results**

IAS Critical Design Review System Test Processes



- **IAS System Integration and Test Plan**
 - Documents the plan and requirements for the Development Verification and Validation
- **System Test Procedures**
 - Contains detailed procedures for each release test, generated 1 month before beginning of each release system test
- **Test Procedures Walkthrough**
 - Conducted 3 weeks before beginning of each release test, insures that the proposed test procedures adequately describe the operation of the system and verify the system requirements implemented for the current release.

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System Test Processes(cont.)



- **System Test Readiness Review**
 - Conducted 1 week before beginning of each release test to ascertain readiness of software and system test activities
- **System Test Reports**
 - Test summary reports are generated within 4 weeks of completion of each release test

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Configuration Control Activities



- **Maintain configured test tool library**
- **Document each test environment (i.e., software versions) via a checklist audit prior to the start of a test period.**
- **Establish and maintain software baseline**
- **Provide cleanup and maintenance of the test environment after each release test**
- **Receive software turnover from the development group, promote units to the test environment, release the system executables and copy them to the test environment**
- **Prepare software installation packages**

IAS Critical Design Review

System Test Activities



System Test Activities

Status

Insure testability of System Requirements	Complete
Insure testability of Software Requirements	Complete
Develop System Integration and Test Plan	Complete
Test Data Requirements	
Test Tool Identification	
Establish Test Schedule	
Develop Necessary Test Tools	In Progress
Develop System Test Procedures	For each release
Create Test Scenarios	
Generate Test Data Sets	
Verify Test Tools	
Develop detailed test schedule per release	
Conduct System Test Readiness Reviews	For each release
Integrate System Components	For each release
Execute System Tests	For each release
Generate Test Summary Reports	For each release

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System Test Tools

<u>TOOL</u>	<u>RESOURCE</u>	<u>STATUS</u>
GTSIM	CNMOS	Reformat L5 to L7 format
LPS	CNMOS	Release 2 in Integration
HDF Swath to HDF	CNMOS	TBD
EDC DAAC Simulator	CNMOS	Release 1
MOC Simulator	CNMOS	Release 1
VSHOW	CNMOS	COTS
Collage	CNMOS	COTS
Database Table Dumps	CNMOS	Complete

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System Test Issues



- **There are 3 test requirements which require post launch data for test verification.**
- **3.2.3.4 The IAS shall be able to create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.**
- **3.2.3.8 The IAS shall provide the capability to perform image-to-image registration to an accuracy of 0.4 multispectral sensor GSD 0.9p , inthe along-track and cross-track directions, providing all inputs are within specification.**
- **3.2.3.10 The IAS shall be capable of estimation the field angles to an accuracy of 0.18 arcsec, 1 sigma.**

IAS Critical Design Review



Agenda

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| • System Test | E. Crook |
| • Conclusion | R. Schweiss |

IAS Critical Design Review



- **Conclusion**

- Training, Maintenance, and Transition
- Open Issues
- Risks
- IAS Release Plan
- Schedule

IAS Critical Design Review



Training, Maintenance, and Transition

- **IAS personnel are working closely with EDC to keep operations and maintenance personnel involved in the IAS design and implementation**
- **IAS Transition Plan will be developed by GSFC with support from EDC to document:**
 - **Transition approach**
 - **Roles and Responsibilities of organizations**
 - **Plan for providing/acquiring products to support transition**
 - **O&M personnel training approach and requirements**
 - **Activities and schedules for transition**
- **The schedule for the IAS Transition Plan is:**
 - **Review: 5/27/97**
 - **Final: 7/1/97**

IAS Critical Design Review



Training, Maintenance, and Transition

- **IAS Installation Plan will be developed by GSFC with support from EDC to document:**
 - Installation strategy, cabling, setup, and checkout
 - Organization support required for installation
 - Problem report and resolution procedures
 - Activities and schedules for installation
- **Schedule for the IAS Installation Plan is:**
 - Review 5/27/97
 - Final 7/1/97

IAS Critical Design Review



Open Issues

- **During ground testing of the ADS transfer functions were not constant over the operating temperature range. The baseline IAS design assumes one transfer function for each of the three ADS units for use in attitude data processing. The impact of the IAS including a thermal dependence in these transfer functions is as follows:**
 - **Analysis of the ADS test results is required to determine the best way to parameterize the ADS transfer functions, i.e. how should the transfer functions be modified**
 - **IAS will need to add the temperature dependent transfer function coefficients to the Calibration Parameter File**
 - **The attitude processing software that uses the ADS temperature data from the PCD to set up the filter transfer functions will require modifications**

IAS Critical Design Review



Risks

- **Development Schedule**
 - There is no schedule slack in the IAS development schedule given the timing of the IAS restructuring.
 - **Mitigation:** Slack will need to be managed by prioritizing requirements. Highest priority functions needed for launch and early check out will be developed first etc. Continue to identify functions that can be deferred until a post launch release (e.g. Sub Interval Processing)
- **Transition to EDC**
 - Given the development schedule and the funding profile, there is insufficient time to properly transition sustaining engineering responsibilities to EDC. If sufficient transition is not provided the system cannot be properly maintained.
 - **Mitigation:** Work with EDC, L7 Project, and NOAA during transition planning to negotiate an acceptable transition schedule



Risks

- **Ground Look Calibration Processing**
 - The Baselined cost and schedule does not include capabilities to Process Ground Look Calibration
 - Mitigation: If Ground Look Processing requirements evolve then cost and schedule impacts will be assessed
- **System Performance**
 - Software application performance on the SGI hardware is not well understood
 - Mitigation: Increase emphasis on prototyping and performance modeling



Rationale

- **Release 1**
 - **Capabilities to support Landsat 7 Ground System Testing activities**
 - **Interfaces to the EDC DAAC and MOC**
 - **Core Level 1 Processing Functionality**
- **Release 2**
 - **Remaining Requirements including all calibration, evaluation, and analysis functions**

IAS Critical Design Review



IAS Release Plan

SUBSYSTEM	RELEASE 1	RELEASE 2
IAS Infrastructure User Interface	Operator Interface	
	Analyst Interface	
IAS Infrastructure Data Management	Ingest Level 0R Products from the EDC DAAC	Create subimage files
	Quality Assess Level 0R Products	Correct MSCD and PCD
	Associate Level 0R Product with Work Order	
	Format Files for Transmission to External Systems	Generate Calibration Parameter File
	Ingest Data from MOC	
	Convert Ephemeris	
	Manage Work Order Directories	Manage Disk Space
IAS Infrastructure Process Control	Start Up IAS	
	Schedule Work Order	
	Process Work Order	
IAS Infrastructure Evaluation & Analysis	Display Level 0R Product files (imagery and ancillary data)	
	Display algorithm results - flat files	
	Display algorithm results - database queries	
		Create reports

IAS Critical Design Review



IAS Release Plan

SUBSYSTEM	RELEASE 1	RELEASE 2
Radiometric Processing Subsystem	Characterize Level 0R image (Dropped Lines, Impulse Noise, Detector Saturation, Histogram Analysis)	Characterize Level 0R image (Memory Effect, Coherent Noise, Random Noise, Scan-Correlated Shift)
		Correct Level 0R image (Memory Effect, Coherent Noise, Scan-Correlated Shift)
	Process IC Reflective and IC Emissive Data (Generate IC gains and biases)	Process FASC and PASC data (Generate FASC and PASC gains and biases)
		Generate Combined Radiometric Model (CRaM)
	Generate Level 1R image (Apply Radiometric Correction)	
	Characterize Level 1R image (MTF, Banding and Striping)	
	Correct Level 1R image (Dropped Lines, Dead Detectors, Saturated Detectors, Banding, Striping)	
Geometric Processing Subsystem	Generate 1Gs and 1Gp Image (Create Model, Generate Grid, Call Model, Resample and Terrain Correct)	
		Perform Geometric Calibration (Sensor Alignment, Scan Mirror, Band Placement)
		Perform Geometric Characterization (Geometric Accuracy, Geodetic Accuracy, Image-to-Image Registration, Band-to-Band Registration)

MO& SD
Division
Code 500

IAS Critical Design Review



Software Sizing Estimates

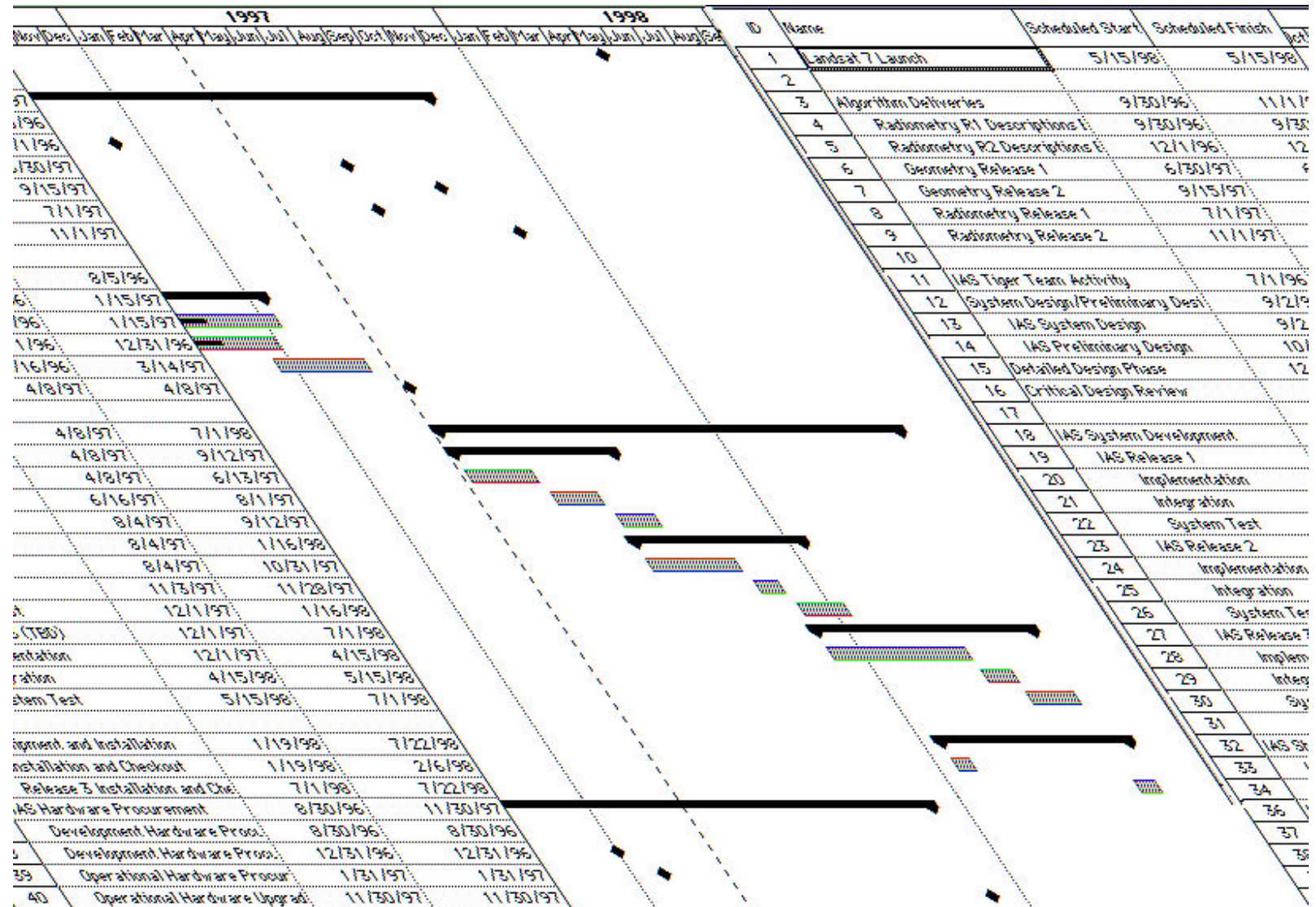
	DSI	Reuse	Release 1	Release 2
Process Control Subsystem (PCS)	1,750	0	1,750	0
Data Management Subsystem (DMS)	8,750	0	3,750	5,000
Evaluation & Assessment Subsystem (EAS)	6,125	0	0	6,125
User Interface (UI)	3,700	0	3,100	600
Database	7,500	0	5,000	2,500
Global & Tools	6,000	0	3,150	2,750
Radiometric Processing Subsystem (RPS)	19,000	5,000	13,425	10,575
Geometric Processing Subsystem (GPS)	16,164	22,776	30,780	8,160
	68,989	27,776	61,055	35,710

MO& SD
Division
Code 500

IAS Critical Design Review



Schedule



IAS Critical Design Review



Acronyms

1Gs	Level 1G systematically corrected data
1Gt	Level 1G terrain corrected data
1Rf	Level 1R FASC processed data
1Rp	Level 1R PASC processed data
ACCA	Automated Cloud Cover Assessment
AN/DN	Ascending Node/Descending Node
API	Application promaatic interface
AUI	Analyst User Interface
B-B	Band to Band
CC	Cubic Convolution
CNMOS	Consolidated Network
	Management and Operations Support
COTS	Commercial Off-the-Shelf
CPF	Calibration Parameter File
CRaM	Combined Radiometric Model
DAAC	Distributed Active Archive Center
DAN	Data Availability Notice
DB	Database
DDR	Data Definition Record
DEM	Digital Elevation Model
DHF	Data Handling Facility
DMS	Data Management Subsystem
E&A	Evaluation and Analysis
EC S	EOSDIS Core System
EDC	EROS Data Center
ENVI	Environment for Visualizing Imagery
ESST	Earth Science Search Tool
ETM+	Enhanced Thematic Mapper Plus

FAC=FASC	Full Aperture Solar Calibrator
FDF	Flight Dynamics Facility
FTP	File Transfer Protocol
GCP	Ground Control Point
GLC	Ground Look Calibration
GPS	Geometric Processing Subsystem
GSFC	Goddard Space Flight Center
GTSIM	Generic Telemetry Simulator
GUI	Graphical User Interface
HDF	Hierarchical Data Format
I-I	Image to Image
IAS	Image Assessment System
ICD	Interface Control Document
IDL	Interactive Data Language
IGS	International Ground Station
L0R	Level-0R product
LOS	Line Of Sight
LPGS	Level 1 Product Generation System
LPS	Landsat 7 Processing System
LSO	Landsat 7 Science Office
MBR	Miniumu m Bounding Rectangle
MMO	Mission Management Office
MO&DSD	Mission Operations and Data Systems Directorate
MO&SD	Mission Operations and Systems Development
MOC	Mission Operations Center
MOSDD	Mission Operations and System Development Division

IAS Critical Design Review



Acronyms (cont'd)

MSCD	Mirror Scan Correction Data	PRT	Product Request Tool
MTF	Modulation Transfer Function	RPS	Radiometric Processing Subsystem
MTFC	Modulation Transfer Function Compensation	SEAS	System Engineering, and Analysis Support
NASA	National Aeronautics and Space Administration	SGI	Silicon Graphics, Incorporated
NN	Nearest Neighbor	SSDM	SEAS System Development Methodology
ODL	Object Description Language	STD	State Transition Diagram
PAC=PASC	Partial Aperture Solar Calibrator	UI	User Interface
PCD	Payload Correction Data	USNO	U.S. Naval Observatory
PCS	Process Control Subsystem		

REVIEW SUBJECT:	CONFIGURATION CONTROL BOARD		NUMBER (FOR CODE 514 CCB USE ONLY)
DATE OF REVIEW:	REVIEW ITEM DISPOSITION		
ORIGINATOR:	ORGANIZATION:	EXTENSION:	
SUBJECT OF COMMENT:			
DOCUMENT TITLE/NUMBER:			
DESCRIPTION OF PROBLEM:			
ORIGINATOR'S RECOMMENDATION:			
IMPACT IF RECOMMENDATION NOT ACCEPTED:			
ACTIONEE'S RESPONSE:			
NAME OF ACTIONEE:	SIGNATURE:	DATE:	
DISPOSITION			
<input type="checkbox"/> APPROVED AS WRITTEN <input type="checkbox"/> APPROVED WITH MODIFICATIONS <input type="checkbox"/> DISAPPROVED			
REVIEW BOARD CHAIRMAN:		DATE:	